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## DIGEST OF NASA EARTH OBSERVATION SENSORS

### ROBERT R. DRUMMOND

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GREENBELT, MARYLAND

### DIGEST OF NASA EARTH OBSERVATION SENSORS

Robert R. Drummond

December 1972

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Greenbelt, Maryland

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### DIGEST OF NASA EARTH OBSERVATION SENSORS

### Robert R. Drummond

### ABSTRACT

A digest of technical characteristics of remote sensors and supporting technological experiments uniquely developed under NASA Applications Programs for Earth Observation Flight Missions is presented. Included are camera systems, sounders, interferometers, communications and experiments. In the text, these are grouped by types, such as television and photographic cameras, lasers and radars, radiometers, spectrometers, technology experiments, and transponder technology experiments. Coverage of the brief history of development extends from the first successful Earth Observation sensor aboard Explorer 7 in October, 1959, through the latest funded and flight-approved sensors under development as of October 1, 1972. A standard resume format is employed to normalize and mechanize the information presented.

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### **FOREWORD**

The successful launching and operation of ERTS-1 represents the beginning of a new era in multispectral remote sensor applications for Earth observation. This major milestone in the NASA Space Applications Program marks the transition to a broad base of multi-discipline data applications programs. The intent of this text is to summarize the technical status of NASA remote sensor developments up to and including this transition point. The compilation of the instrument resumes required the cooperation and assistance of many individual investigators, project personnel, and program offices, and these efforts are greatly appreciated. The author wishes to acknowledge the continued support for this task by Mr. Jules Lehmann, Earth Observation Programs, Office of Applications, NASA Headquarters. Also the author wishes to thank the staff of IIT Research Institute for their efforts, particularly Norbert M. Katz, Sidney S. Verner, and Joseph E. Orth.

### ACRONYMS AND DEFINITIONS

### Spacecraft Acronyms

| Applications Technology Satellite                             |
|---|
| Earth Resources Technology Satellite                          |
| Environmental Science and Services Administration             |
| (Predecessor to NOAA)   |
| Geodetic Earth Observatory Satellite                          |
| Improved Tiros Operational Satellite                          |
| National Oceanic and Atmospheric Administration               |
| Synchronous Meteorological Satellite                          |
| A name derived from Television Infrared Observation Satellite |
| Tiros Operational Satellite                                   |
|   |

### Program Names

| Apollo   | Manned Lunar Program Series                                    |
|----------|--|
| Explorer | Scientific Satellite Program Series                            |
| Nimbus   | Meteorological Research Satellite Program Series               |
| Skylab   | Manned Space Station Experiment                                |
| Tiros    | Meteorological Satellite Program Series leading to Operational |
|          | Meteorological Spacecraft                                      |

### Earth Resources Survey Aircraft

| C-130 A/C | Aircraft assigned to NASA as instrument carriers |
|-----------|--|
| NP3AA/C   | Aircraft assigned to NASA as instrument carriers |

### Spacecraft Designations

Preflight and postflight designations for spacecraft are utilized in the text. The following NASA procedures apply to these designations:

- 1. Preflight: Spacecraft acronym or name followed by a letter (Example, ERTS-A) designates program sequence number for that individual spacecraft
- Postflight: Preflight program sequence letter is replaced by a flight sequence number (Example, ERTS-A became ERTS-1)
- 3. Where NASA produces and launches operational satellites for another agency the name changes from a NASA to an agency designation at the time

### ACRONYMS AND DEFINITIONS (Continued)

the operating spacecraft is delivered to the agency in orbit. (Example: ITOS-A became NOAA-1)

4. Program and flight sequence designations are independent and do not necessarily coincide. (Example ITOS-D became NOAA-2)

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Frontispiece. An example of transmitted imagery from orbit, showing quality of detail attainable from ERTS-1 Multispectral Scanner. The scene is the Chesapeake Bay area including Washington, D.C. and Baltimore, Maryland. The image is from a single visible band (MSS Band 5) in the green extending from 0.5 to 0.6 microns, October 11, 1972, altitude 915 km (569 statute miles).

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### DIGEST OF NASA EARTH OBSERVATION SENSORS

### INTRODUCTION

This report has been prepared as a digest of NASA Spaceborne Instrumentation, developed for Earth Observation Missions under the Space Applications Program. Historical coverage extends from the beginning of practical Earth Observation Space Missions, through the latest approved future flight experiment, as of October 1, 1972. The digest consists of a compilation of individual experiment resumes. A standard resume format was adopted to both normalize and mechanize the information presented.

All NASA sponsored experiments, representing significant steps in earth observation technology, were reviewed. The criteria of experiment selection for inclusion in the text are as follows:

- 1. Only custom designed spaceflight experiments were considered.
- 2. Only experiments contributing direct or indirect advances in earth observation sensor technology were included.
- 3. Past experiments were included that have successfully flown and have returned usable Earth Observation Data.
- 4. Future spaceflight experiments were included that were mission-approved and funded prior to October 1, 1972.

Some flight experiments were deleted by following the above criteria. These fall into two general categories.

- 1. Those experiments whose flights were unsuccessful and little or no significant data was returned from the effort.
- 2. Experiments utilizing "off-the-shelf" type hardware for Earth Observation, such as hand-held film cameras, etc.

Certain exceptions were taken to these criteria where remote sensor technological advances were significant.

1. The Day-Night Camera System (DNCS) was included (ref. page 42) even though the ATS-4 flight was unsuccessful, since the camera represented a significant effort in adapting the image orthicon TV tube to space applications.

2. Two custom-designed remote sensors, the Experimental 24-Channel Multispectral Scanner (ECMSS) (ref. page 106) and the Passive Microwave Imaging System (PMIS) (ref. page 178) are included, even though they were designed as Earth Observation Experiments aboard aircraft. Both are to be utilized in the Earth Resources Survey Aircraft Program. Each represents a significant milestone in Earth Observations sensor applications.

The task of collection of experiment information was initiated in 1968 by the NASA Electronics Research Center, Cambridge, Mass. under NASA Headquarters Task 160-44-02-28-25, Jules Lehmann, Program Manager. The ERC effort was under the technical direction of Raymond A. Minzer and John D. Oberholtzer. Contract NAS12-666 was awarded to IIT Research Institute to collect and develop experiment resumes and to develop an information storage and retrieval computer program for same. In the first quarter of 1970, prior to the liquidation of ERC, the project was transferred to the Goddard Space Flight Center, for continuation of the effort under the direction of Robert R. Drummond. Contract NAS 5-21557 was awarded IIT Research Institute to update and complete the resume effort. This contract was completed in October, 1972.

Under this effort, the resume format, as originally developed at ERC, was held constant. Attention was paid to completing the coverage of the resumes across the entire NASA Earth Observation Mission spectrum.

This text is thought to be the only up-to-date reference, summarizing custom-designed NASA Earth Observation Experiments in a single document. Only real instrumentation hardware aspects are represented. If an experiment had already flown before October 1, 1972, the resume should be representative of the actual flight configuration and not subject to further change. However, if an experiment was still under development for a future flight on this date, some changes could usually be expected as the experiment progresses through the development cycle from "approved proposal" to "flight-qualified hardware." In these cases, resume data should be checked with the principal investigator before use. In anticipation of this, a space for notes is left in the lower-right-hand corner of the resume for the convenience of the user.

### HISTORY OF EARTH OBSERVATION

The history of NASA Earth Observation Space Missions spans only a little over a decade. During this brief period, both Earth Observation objectives and custom designed sensor instrumentation have experienced exponential growth. The primary driving force behind these advances has been the NASA Meteorological Research Program. The practical beginning of the era started with the successful flight of Explorer 7 in October, 1959.

This scientific research spacecraft carried a uniquely designed sensor by Dr. V. E. Soumi, University of Wisconsin. Its title was, "Low Resolution Omnidirectional Radiometer" (LROR) (ref. page 150). The basic experimental objective was to map the "gross heat budget" of the Earth, and to determine how much solar energy is absorbed or reflected by the Earth and its atmosphere. This early spaceborne sensor has the distinction of being the first successful Earth Observation instrument to return usable data from space.

The first practical imagery from space, showing the Earth and its cloud cover, were obtained by two vidicon TV camera systems aboard the first satellite dedicated to meteorological research, TIROS I (April 1960). These cameras included features such as a shutter, slow TV readout of a long persistance image on the exposed vidicon tube, relatively low power and nominal bandwidth. Each camera had a different optical field of view, one narrow angle (VCSN) and the other wide angle (VCSW).

The flight of TIROS I was the first of a successful series of flights embodying similar spin-stabilized spacecraft and sensors. These pioneered global monitoring of cloud cover and soon proved valuable in detecting and tracking major weather phenomena such as frontal systems, hurricanes, etc.

New and revolutionary information is always followed by a slower learning period, before utility can be fully appreciated and future requirements defined. So it was with the early meteorological research program. Lags in new sensor applications were present in the TIROS program as knowledge was accumulated on operational capabilities of flight systems. This resulted in considerable repetition in spacecraft/sensor flights in a pseudo-operational mode, before advances in instrumentation were incorporated.

Offset approximately three years in a later time frame, the Nimbus Meteorological Research Satellite Program became the primary catalyst for remote sensor developments. The larger Nimbus payload capability and three-axis stabilized, Earth-oriented configuration, opened up new possibilities for sensor instrumentation.

Nimbus was initially conceived as an operational weather satellite. However, it was actually developed as the primary NASA meteorological research vehicle. As the follow-on research oriented effort, Nimbus spawned the bulk of remote sensor developments for Earth Observation in the middle period of the decade. The program still accounts for a major share of sensor experiments, although several Earth Observation Programs are active today.

The Application Technology Satellite Program (ATS), initiated in the middle 60's, stimulated imagery and technological support experiments from geosynchronous orbit. However, only the spin-stabilized spacecraft were successful. Launch and spacecraft failures plagued the series of gravity gradient-stabilized spacecraft and limited the realization of further geosynchronous earth observation development.

The middle period saw the TIROS configuration developed into the world's first operational weather satellites, the TOS series. These were designed, manufactured, and launched by NASA. They were funded and operated by the Environmental Science and Service Administration (ESSA), the predecessor to the National Oceanic and Atmospheric Administration (NOAA). The TOS/ESSA series utilized sensors that were adapted for operational use from sensors developed and proven in the Nimbus Meteorological Research Program. These spacecraft played a pioneering role in the development of operational earth observation procedures.

Exponential growth of Earth Observation requirements began to reach significant proportions in the latter quarter of the decade. Greater sophistication in measurement objectives and the growth of data applications were the dominate forces. Experiments aboard Nimbus III and IV created new vistas in observable information about atmospheric processes. Improvements under development for Nimbus E and F experiments, and the (despun-platform type) ITOS/NOAA second generation operational weather satellite program are pushing the state of the art in applications of remote sensors for low altitude global monitoring. These are being paralleled with continuous monitoring type geosynchronous orbit experiments under development for ATS-F and SMS-A.

In general, developments have gravitated toward multi-spectral imagers, radiometers, sounders, interferomenters, etc. for sampling, measuring and collecting atmospheric and surface information. These provide important inputs to analysis of global atmospheric circulation and weather distributions. The evolution of global weather analysis is still in its infancy, but showing signs of becoming an adolescent by the mid 70's. The current crop of developmental experiments, described herein, are expected to bring this about, as they reach the flight stage and generate new and improved data.

Possibly the most potent force for molding the future of remote sensing from orbit was begun in the latter quarter of the decade. This was the initiation of the Earth Resources Survey Program. This multisided Earth Observation program encompasses the Earth Resources Technology Satellite Research Program (ERTS), the Earth Resources Experiment Package (EREP) aboard Skylab A, and the Earth Resources Survey Aircraft Program.

Sensor requirements differ from those of the meteorology program by demanding spatial, spectral, and temporal data of generally higher resolution. Attention is also focused on the Earth's surface. The best compromises are required between identification of Earth details in multispectral bands, detector technology, imagery, radiometry, data rates, fields of view, stability, and periodic coverage. The state of the art in remote sensors is being pushed. ERTS-A, Skylab A, C-130 Aircraft, and NP3A Aircraft experiment payloads represent the exploratory first generation instruments in the Earth Resources Survey Program.

The anticipated utilization of data from these sensors is mushrooming at a fast rate. This was convincingly demonstrated in 1971 by the receipt of approximately 700 proposals for multidiscipline applications of ERTS-A/EREP data in response to a NASA request for data experiments. Ideal objectives require utilization of sensor output data to the theoretical limits of resolution. This implies systems and data processing precision never before attained from a space platform. Practical limitations are almost certain to govern the limits of initial utility for some users. However, one thing appears firm, the direction for instrumentation development is toward optimization to serve the widest user community. The future utilization of Earth Resources data has the potential for direct application in almost every phase of human endeavor. The sophistication of sensor developments is expected to be paced by major growth of the data user community. Each new application contributes to an expanding base of technical knowledge about the Earth. It also adds to the many benefits accruing from the overall space program. Piece by piece, the operating rules and constraints governing the global environment are being envolved through these efforts.

This brief history of sensor development has been presented to assist the reader in comprehending the significance of the decade covered by the resumes. As experiments grow in sophistication, so do the lead times for technical development and use. Elapsed time from concept to flight can be from three to five years. An additional three years can easily elapse between experimental and operational application. Operational applications tend to increase requirements for service life expectance. Past experience with sensors have been in the one-to-two year service life category. New requirements are pushing toward the 5-year goal. This means that possibly a number

of the sensors summarized herein, will remain active for Earth Observation throughout the mid 1970's period.

### TELEVISION AND PHOTOGRAPHIC CAMERAS

### INSTRUMENT RESUME

### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION **GODDARD SPACE FLIGHT CENTER**

GREENBELT MD 20771

|                                |                 |        | GREEN BEET,          | ND. 20771 |                  |                  |                    |                    |      |                 |
|--------------------------------|-----------------|--------|----------------------|-----------|------------------|------------------|--------------------|--------------------|------|-----------------|
| 1. TITLE                       |                 |        |                      |           |                  |                  |                    | ACRONYM            | 3. E | EXP NO          |
| ADVANCED VIDICUN CAMERA SYSTEM |                 |        |                      |           |                  |                  |                    | C S                |      |                 |
| (TITLE CONT                    | .)              |        |                      |           | -                |                  | 4. R               | ESUME DATE         |      | 5.<br>VERSION   |
|                                |                 |        |                      |           |                  |                  | 0.9                | 70177              |      | 2005            |
| 6. PRINCIPAL I                 | NVESTIGATOR     | 7. OF  | RGANIZATION          |           |                  | 8. T             | ELEPHO             | NE                 | ,    |                 |
| ALBERT, .                      | J.              | NES    | C/NOAA               |           |                  | 202              | -655               | -4000              |      |                 |
| 9. CO-INVESTI                  | GATOR           | 10. OF | RGANIZATION          |           |                  | 11. T            | ELEPHO             | NE                 |      |                 |
|                                | _               |        |                      |           |                  |                  |                    |                    |      |                 |
| 12. CONTRACT<br>TYPE           | 13. CONTRACT NU | MBER   | 14. FLASH INDI       | EX NUMBER | 15 START<br>DATE | 16. <sup>C</sup> | OMPLETION DATE     | PLETION 17. STATUS |      |                 |
|                                |                 |        | _                    |           | <u> </u>         |                  |                    | POST               | ۴L   | <b>IGHT</b>     |
| 18. MONITOR                    |                 | 19. AC | GENCY 20. PGM OFFICE |           |                  | 21. TELEPHONE    |                    |                    |      |                 |
| GLOVER, .                      | J.C.            | NES    | CINDAA               |           |                  | 202              | <del>-</del> 655   | -4000              |      |                 |
| 22. VENDOR                     |                 |        | 23. LOCATION         |           |                  |                  | 24. FLIGHT<br>DATE | 25. L              | EAD  | TIME            |
| RCA ASTR                       | O-FLECTRUNI     | CS     | PRINCETON            | N.J.      |                  |                  | 10/6               | 6 NA               |      |                 |
| 26. INSTRUMEN                  | NT TYPE         |        |                      |           |                  |                  |                    |                    |      | 27.<br>SECURITY |
| IMAGER,                        | 1-INCH WIDE     | -ANGL  | E HIGH-RES           | SOLUTION  | VID              | ICON             | 1                  |                    |      | UNC             |
| 28. APPLICATIO                 | NC              |        |                      | 2         | 9. SPACE         | CRAF             | T                  |                    |      |                 |
| MET, ERSI                      | p               |        |                      | E         | SSA :            | 3                |                    |                    |      |                 |
| 30. PURPOSE                    |                 |        |                      |           |                  |                  |                    |                    |      |                 |

PRIMARY-TO PROVIDE METEOROLOGICAL DATA IN THE FORM OF WIDE-ANGLE HIGH-RESOLUTION TELEVISION PICTURES OF EARTH'S CLOUD COVER, BY TPANSMITTING PRERECORDED TV PICTURES TO CDA STATIONS.\*\*\*SECOND-ARY-MAINTAIN OPERATIONAL CAPABILITY OF THE AVCS.

### 31. PRINCIPLES OF OPERATION

THE AVCS, TEST FLOWN ON NIMBUS 1 AND 2 AND OPERATIONALLY ON ESSA 3 AND 5, ARE SIMILAR EXCEPT FOR DIFFERENT CAMERA LENSES AND ESSA HAVING 2 CAMERAS WHILE NIMBUS HAD 3. THE ESSA SYSTEM CONSISTS OF 2 IDENTICAL 1-INCH VIDICONS HAVING 800 TV LINE RESOLUTION. THE CAMERAS ARE MOUNTED 180 DEGREES APART ON THE SIDE OF THE SPACE-CRAFT AND PERPENDICULAR TO THE SPIN AXIS. DURING PICTURE TAKING SEQUENCE THE CAMERA LOOKS AT THE NADIR. THE LENS IS A TEGEA KIN-OPTIC 108 DEGREE WIDE ANGLE LENS WITH A FOCAL LENGTH OF 5.7 MM AND AN ELECTROMAGNETICALLY CONTROLLED SHUTTER. THE CAMERA CON-VERTS THE OPTICAL IMAGE TO AN ELECTRICAL SIGNAL WHICH IS PRO-CESSED AND RECORDED ON A MAGNETIC TAPE RECORDER. THE VIDICON HAS AN INHERENT STORAGE PROPERTY WHICH PERMITS A NOMINAL 6.5 SECOND FRAME TIME. CONCURRENTLY WITH SHUTTER ACTUATION, A 16-INCRE-MENT GRAY SCALE IS INCLUDED AT THE EDGE OF EACH PICTURE FRAME AS A CONTRAST CHECK. THE CAMERA IS INDEPENDENTLY TRIGGERED INTO OPERATION ONLY WHEN IT COMES IN VIEW OF THE EARTH; THIS IS DONE BY A HORIZON CROSSING INDICATOR(HCI), ONE FOR EACH CAMERA. THE CAMERA CAN TAKE 6 OR 12 CLOUD COVER PICTURES PER ORBIT AT 260-SECOND INTERVALS WITH A 50 PERCENT OVERLAP.

### 32. PHENOMENA OBSERVED

CLOUD COVER OF EARTH (REFLECTED VISIBLE SOLAR RADIATION)

### 33. MEASUREMENT RANGE

DYNAMIC RANGE OF 14 TO 11,400 FOOT-LAMBERTS

### 34. PRECISION AND ACCURACY

BOO TV-LINE RESOLUTION; 16 LEVELS OF GRAY

| 35. SPECTRAL RANGE                |  |  |          | 36. SI             | PECTR       | AL R                                   | ESOLU            | TION                                   | 37. TIM | E CONSTANT     |
|-----------------------------------|--|--|----------|--------------------|-------------|--|------------------|--|---------|----------------|
| 38. FIELD OF VIEW                 |  | 39. GROUNE   | ) CHAIA  | TU                 |             |  |                  |  | <u></u> |                |
|                                   |  |  |          |                    | 700         | NM                                     | FRN              | M 75                                   | O NM    | ALTITUDE       |
| 40. ANGULAR RESOLUTION 4          |  |  | , , , ,  |                    |             |  |                  |  |         | 7.212.7002     |
|                                   | 1.4 NM PER   |  | NE .     | ΔT                 | THE         | NAC                                    | IR               | FROM                                   | 750     | NM ALT         |
| 42. POINTING ACCURACY 43.         |  |  | ALTI     |                    |             |  |                  | NCLINA                                 |         |                |
| 0.5 DEG                           |  |  |          |                    |             | AR                                     | SU               | N-SY                                   | NCH     | RETROGRADE     |
| 46. SPECIAL REQUIREME             | ENTS   | The state of the s |          |                    |             |  | <del> </del>     |  | · .,    |                |
|                                   |  |  | ,        | - Jan v            |             |  |                  |  |         |                |
| 47. COMPONENTS                    |  |  |          |                    |             |  |                  |  |         |                |
| 2 TV CAMERA S'                    | YSTEMS, 2  | TAPE R   | ECO      | RDE                | 25.         | SYS                                    | TEM              | ELE                                    | CTRON   | NICS           |
| 48. WEIGHT 49. VOLU               | JME  | 50. AVERAG   | E POWE   | R 5                | I. STAN     | DBY PC                                 | MAKE IN          | 52. PEA                                | K POWE  | R 53. MTBF     |
| 43 LB                             |  | 16   |          |                    |             |  |                  |  |         |                |
| 54 INTERFERENCE 55 MAG            |  | CLEAR<br>RFERENCE  | 57. INTE | RFEREN             | CE          |  | SHIEL            |  |         |                |
|                                   | SITIVE   |  |          |                    |             | MA                                     | GNE              |  |         | DING USED      |
| 59. CALIBRATION                   |  | 60. DAT/   |          |                    | <del></del> |  |                  | 7 1 1                                  |         | OF OBSERVATION |
| GRAY-SCALE CA                     | - WASTER AND TO THE TOTAL PROPERTY OF THE TO | DELA   | YED      | 1 E                | LEME        | : 1 K Y                                | ,<br><del></del> | LUAY                                   | 21DF    | OF ORBIT       |
| 62. TELEMETRY REQUIR              |  | ( ON CD  | A C      | TAT                | TON         | COL                                    | IM A L           | D 111                                  | A Tir   | CDACE          |
| RECORDER IS PI<br>  CRAFT 235-MHZ |  |  |          |                    |             |  |                  |  |         |                |
| OF PICTURES I                     |  |  |          |                    |             |  | . IT C           | ruk                                    | A FUL   | וומאט ו.       |
| 63. ADVANTAGES AND L              |  | TAIELT   | ) m      | INU                | 1 5 3       |  |                  | ······································ |         |                |
| DUE TO CAMERA                     |  | DICTHE   | FS       | ARE                | TAK         | EN                                     | CT2              | AIGH                                   | T DOL   | JN MTNITMT7    |
| ING DISTORTION                    |  |  |          |                    |             |  | 317              | 41()11                                 | 1 907   | ANA SHINAINEE  |
| 64. REFERENCES                    |  |  |          | <u>~ ~ · · · ·</u> | <u> </u>    | ······································ |                  | ************************************** |         | ·              |
| 1) FINAL ENGIN                    | EFRING REF   | PORT TO  | S A      | VO.                | 1.          | 2.3                                    | RC.              | A AS                                   | TRO-F   | LECTRONICS     |
| CONTRACT NO. 1                    |  |  |          | •                  |             |  |                  |  |         |                |
| APP 1966. NAS                     |  |  |          |                    |             |  |                  |  |         |                |
| OF SPACE CAME                     |  |  |          |                    |             |  |                  |  |         |                |
| 1968.***4) DA                     | TA AVAILAE   | BLE FROM   | M N      | TI                 | ONAL        | . WE                                   | HTA              | ER R                                   | ECORD   | S CTR          |
| (ESSA), ASHEV                     |  |  |          |                    |             |  |                  |  |         |                |
| 66. HISTORICAL REMAR              | Service and the service and th | 4  |          |                    |             |  |                  |  |         |                |
| SIMILAR TO AVE                    | CS ON NIME   | SUS 1 A  | ND :     | 2, /               | AND         | ESS                                    | A 5              | •                                      |         |                |
|                                   |  |  |          |                    |             |  |                  |  |         | •              |
| ,                                 |  |  |          |                    |             |  |                  |  |         |                |
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|                                   |  |  |          |                    |             |  |                  |  |         |                |

### INSTRUMENT RESUME

## NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771

|                           |                  |            | G,                  | <del>-</del>                          |          |               |                           |                   |                 |
|---------------------------|------------------|------------|---------------------|---------------------------------------|----------|---------------|---------------------------|-------------------|-----------------|
| 1. TITLE                  |                  |            |                     |                                       |          |               | 2. A                      | CRONYM            | 3. EXP NO       |
| ADVANCED                  | VIDICON CAN      | 4ERA       | SYSTEM              |                                       |          |               | _ A V                     | CZ                |                 |
| (TITLE CONT               | 1).              |            |                     |                                       |          |               | 4, RE                     | SUME DATE         | 5.<br>VERSION   |
|                           |                  |            |                     |                                       |          |               | 09                        | 7017              | /2 0005         |
| 6. PRINCIPAL              | INVESTIGATOR     | GANIZATION |                     |                                       | 8. TE    | ELEPHO        | NE                        |                   |                 |
| ALBERT.                   | J.               | NES        | CZNOAA              |                                       |          | 202           | 2-655                     | <del>-</del> 4000 | ,               |
| 9. CO-INVESTIGATOR 10. OF |                  |            | GANIZATION          |                                       |          | 11. T         | ELEPHO                    | NE                |                 |
|                           |                  |            |                     |                                       |          |               |                           |                   |                 |
| 12. CONTRACT<br>TYPE      | 13. CONTRACT NUM | /BER       | 14. FLASH INDEX     | 14. FLASH INDEX NUMBER 15. START DATE |          |               | 16. COMPLETION 17. STATUS |                   |                 |
|                           |                  |            |                     |                                       |          |               |                           | POST              | FLIGHT          |
| 18. MONITOR               |                  | 19. AG     | ENCY 20. PGM OFFICE |                                       |          | 21. TELEPHONE |                           |                   |                 |
| GLOVER,                   | J.C.             | NES        | CZNOAA              |                                       |          | 202           | 2-655                     | <b>-4</b> 000     | -               |
| 22. VENDOR                |                  |            | 23. LOCATION        |                                       |          |               | 24. FLIGHT<br>DATE        | 25. L             | EAD TIME        |
| RCA ASTR                  | O-ELECTRONIC     | C S        | PRINCETON           | , NEW                                 | JERSE    | Υ             | 04/6                      | 7 NA              |                 |
| 26. INSTRUME              |                  |            |                     |                                       |          |               |                           |                   | 27.<br>SECURITY |
| IMAGER,                   | 1-INCH WIDE      | -ANGL      | E HIGH-RES          | OLUTIO                                | AID      | ICO           | V                         |                   | SECURITY<br>UNC |
| 28. APPLICATION           | ON               |            | ·                   | 2                                     | 9. SPACE | CRAF          | T                         |                   |                 |
| MET, ERS                  | P                |            |                     |                                       | ESSA     | 5             |                           |                   |                 |
| 30. PURPOSE               |                  |            |                     |                                       |          |               |                           |                   |                 |

PRIMARY-TO PROVIDE METEOROLOGICAL DATA IN THE FORM OF WIDE-ANGLE HIGH-RESOLUTION TELEVISION PICTURES OF EARTH'S COULD COVER, BY TRANSMITTING PRERECORDED TV PICTURES TO CDA STATIONS.\*\*\*SECOND-ARY-MAINTAIN OPERATIONAL CAPABILITY OF THE AVCS.

### 31. PRINCIPLES OF OPERATION

THE AVCS, TEST FLOWN ON NIMBUS 1 AND 2 AND OPERATIONALLY ON ESSA 3 AND 5. ARE SIMILAR EXCEPT FOR DIFFERENT CAMERA LENSES AND ESSA HAVING 2 CAMERAS WHILE NIMBUS HAD 3. THE ESSA SYSTEM CONSISTS OF 2 IDENTICAL 1-INCH VIDICONS HAVING 800 TV LINE RESOLUTION. THE CAMERAS ARE MOUNTED 180 DEGREES APART ON THE SIDE OF THE SPACE-CRAFT AND PERPENDICULAR TO THE SPIN AXIS. DURING PICTURE TAKING SEQUENCE THE CAMERA LOOKS AT THE NADIR. THE LENS IS A TEGEA KIN-OPTIC 108 DEGREE WIDE ANGLE LENS WITH A FOCAL LENGTH OF 5.7 MM AND AN ELECTROMAGNETICALLY CONTROLLED SHUTTER. THE CAMERA CON-VERTS THE OPTICAL IMAGE TO AN ELECTRICAL SIGNAL WHICH IS PRO-CESSED AND RECORDED ON A MAGNETIC TAPE RECORDER. THE VIDICON HAS AN INHERENT STORAGE PROPERTY WHICH PERMITS A NOMINAL 6.5 SECOND FRAME TIME. CONCURRENTLY WITH SHUTTER ACTUATION, A 16-INCRE-MENT GRAY SCALE IS INCLUDED AT THE EDGE OF EACH PICTURE FRAME AS A CONTRAST CHECK. THE CAMERA IS INDEPENDENTLY TRIGGERED INTO OPERATION ONLY WHEN IT COMES IN VIEW OF THE EARTH; THIS IS DONE BY A HORIZON CROSSING INDICATOR (HCI), ONE FOR EACH CAMERA. THE 4 TRACK MAGNETIC TAPE RECORDER CAN STORE UP TO 36 PICTURES. EACH CAMERA CAN TAKE 6 OR 12 CLOUD COVER PICTURES PER ORBIT AT 260-SECOND INTERVALS WITH A 50 PERCENT OVERLAP.

### 32. PHENOMENA OBSERVED

CLOUD COVER OF EARTH (REFLECTED VISIBLE SOLAR RADIATION)

### 33, MEASUREMENT RANGE

DYNAMIC RANGE OF 14 TO 11400 FOOT-LAMBERTS

### 34. PRECISION AND ACCURACY

800 TV-LINE RESOLUTION; 16 LEVELS OF GRAY

| 35. SPECTRAL RANGE                        |             |           |                   | AL RE  | SOLUTION    | 37. TIME CONSTANT     |          |
|---|-------------|-----------|-------------------|--------|-------------|-----------------------|----------|
| 0.45 TO 0.65                              | MI          | CRON      | ŊΔ                |        |             | 40.0 MILL             | 2FC      |
| 1   |             | UND SWA   |                   |        |             |                       |          |
| 89.0 BY 89.0 DEG 1                        | 700         | NM BY     | 1700              | NM     | FROM 75     | O NM ALTITUD          | <u>E</u> |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESOLU |             |           |                   |        |             |                       |          |
| C.11 DEG 1.4 NM PER T                     | V-L         | INE AT    | CENT              | ER F   | ROM 750     | NM ALTITUDE           |          |
| 42. POINTING ACCURACY 43. POINTING RATE   |             | 44. ALTI  | TUDE              |        | 45. INCLINA | ATION                 |          |
| 0.5 DEG                                   |             | MED       | CIPCU             | ΔR     | SUN-SY      | NCH RETROGR           | ADE      |
| 46. SPECIAL REQUIREMENTS                  |             |           |                   |        |             |                       |          |
|   |             |           |                   |        |             |                       |          |
| 47. COMPONENTS                            |             |           |                   |        |             |                       |          |
| 2 TV CAMERA SYSTEMS, 2 T                  |             |           |                   |        |             |                       |          |
| 48. WEIGHT 49. VOLUME                     | 50. AVE     | RAGE POWE | R 51. STAN        | DBY PO | WER 52. PEA | K POWER 53. MTBF      |          |
| 43 LB                                     |             | 6 WATT    |                   |        |             |                       |          |
| 54- INTERFERENCE 55. MAGNETIC 56. NUCLE   | AR<br>RENCE | 57. TH    | ERMAL<br>RFERENCE | 58.    | SHIELDING   |                       |          |
| SENSITIVE                                 |             |           |                   | МД     | GNETIC      | SHIELDING US          | ED_      |
| 59. CALIBRATION                           | 60. D       | ATA REC   | OVERY             |        | 61. FRE     | QUENCY OF OBSERVATION | 4        |
| GRAY-SCALE CALIBRATION                    | DE          | LAYED     | TELEM             | TRY    | DAY         | SIDE OF ORBI          | T        |
| 62. TELEMETRY REQUIREMENTS                |             |           |                   |        |             |                       |          |
| RECORDER IS PLAYED BACK                   |             |           |                   |        |             |                       |          |
| CRAFT 23,5-MHZ TRANSMITTE                 | R.          | TRANSM    | HISSIO            | IT V   | ME FOR      | À FULL DRBIT          | İ        |
| OF PICTURES IS APPROXIMA                  | TEL         | Y 3 MI    | NUTES.            |        |             |                       |          |
| 63. ADVANTAGES AND LIMITATIONS            |             |           | ,                 |        |             |                       |          |
| DUE TO CAMERA MOUNTING P                  | ICT         | URES A    | RE TA             | KEN    | STRAIGH     | T DOWN MINIM          | IZ-      |
| ING DISTORTION AND INCRE                  | AS I        | NG ACC    | CUR ACY           | •      |             |                       |          |
| 64. REFERENCES                            |             |           |                   |        |             |                       |          |
| 1) FINAL ENGINEERING REPO                 | PT          | TOS A     | VOL 1             | ,2,3   | .RCA AS     | TRO-ELECTRON          | ICS      |
| CONTRACT NO. NAS 5-9034.                  |             |           |                   |        |             |                       |          |
| APP 1966. NASA SP-156, 1                  | 967         | . * * * 3 | OSTR              | TW,H   | .: REVI     | EW OF A DECA          | DE       |
| OF SPACE CAMERA SYSTEMS                   | DEV         | ELOP.     | FOR MI            | ETEO   | POLOGY.     | NASA/GSFC,A           | UG.      |
| 1968.***4) DATA AVAILABL                  | E F         | AV MOR    | TIONAL            | _ WE   | ATHER R     | ECORDS CTR            |          |
| (ESSA), ASHEVILLE, N.C.                   |             |           |                   |        |             |                       |          |
| 65. HISTORICAL REMARKS                    |             |           |                   |        |             |                       |          |
| SIMILAR TO AVCS ON NIMBU                  | S 1         | AND 2     | AND               | ESS    | A 3.        |                       |          |
|   |             | <u></u>   |                   |        |             |                       |          |
|   |             |           |                   |        |             |                       |          |
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GREENBELT, MD. 20771

| 1. TITLE        | ,                 |        |                    |         |                   |              | 2. /              | ACRONYM    | 3.1 | EXP NO          |  |
|-----------------|-------------------|--------|--------------------|---------|-------------------|--------------|-------------------|------------|-----|-----------------|--|
| ADVANCED        | VIDICON CAM       | ERA    | SYSTEM             |         |                   |              | ΙΔ١               | vc s       |     |                 |  |
| (TITLE CONT.    |                   |        |                    |         |                   |              | 4. R              | ESUME DATE |     | 5.<br>VERSION   |  |
|                 |                   |        |                    |         |                   |              | 0.9               | 9/01/      | _   | 0005            |  |
| 6. PRINCIPAL II | NVESTIGATOR       | 7. OR  | GANIZATION         |         |                   | 8. TI        | ELEPHO            | NE         |     |                 |  |
| ALBERT,         | J.                | NES    | C/NOAA             |         |                   | 202-655-400C |                   |            |     |                 |  |
| 9. CO-INVESTIG  |                   | 10. OR | GANIZATION         |         |                   | 11. T        | ELEPHO            | NE.        |     |                 |  |
|                 |                   |        |                    |         |                   |              |                   |            |     |                 |  |
| 12. CONTRACT    | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | MBER    | 15. START<br>DATE | 16. C        | OMPLETION<br>DATE | 17. STA    | rus |                 |  |
|                 |                   |        |                    |         |                   |              |                   | POST       | FL  | IGHT            |  |
| 18. MONITOR     | <u> </u>          | 19. AG | ENCY               | 20. PGN | OFFICE            | 21. T        | ELEPHO            | ONE        |     |                 |  |
| GLOVER,         | J.C.              | NES    | C/NOAA             |         |                   | 20           | 2-65              | 5-400      | 2   |                 |  |
| 22. VENDOR      |                   |        | 23. LOCATION       |         |                   |              | 24. FLIGHT        | 25. L      | EAD | TIME            |  |
| RCA ASTR        | O-ELECTRONIC:     | S      | PRINCETON, I       | N.J.    |                   |              | 0876              | 58         |     |                 |  |
| 26. INSTRUMEN   |                   |        |                    |         |                   |              |                   |            |     | 27.<br>SECURITY |  |
| IMAGER.         | 1-INCH WIDE-      | ANGLI  | E HICH-RESOL       | UTIO    | N VID             | ICO          | N                 |            |     | UNC             |  |
| 28. APPLICATIO  |                   |        |                    |         | 9. SPACE          |              |                   |            |     |                 |  |
| MET, ERS        | P                 |        |                    |         | ESSA-             | 7 ·          |                   |            |     |                 |  |
| 30. PURPOSE     |                   |        |                    |         |                   |              |                   |            |     |                 |  |
|                 |                   |        |                    |         |                   |              |                   |            |     |                 |  |

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SECONDARY-TO MAINTAIN OPERATIONAL CAPABILITY OF THE AVCS.

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### 34. PRECISION AND ACCURACY

833-LINE RESOLUTION, 16 LEVELS OF GRAY

| 35. SPECTRAL      | RANG  | E                |      |                |          |           |      |                |                    | 36       | SPF          | CTR           | AL R         | ESOI         | UTI      | ON  | 37   | TIM        | IE C       | ONS  | TANT  |   |
|-------------------|-------|------------------|------|----------------|----------|-----------|------|----------------|--------------------|----------|--------------|---------------|--------------|--------------|----------|-----|--|------------|------------|--|-------|---|
| 0.45              |       | <u> </u>         |      | 0.             | 65       |           | MI   | CRO            | NS                 |          |              | <u> </u>      |              |              |          |     | <del>                                     </del> | 40         |            |  | ILL   |   |
| 38. FIELD OF V    |       |                  |      |                |          |           |      | UND            |                    |          |              |               |              |              |          |     | <b></b>  | - (-       |            |  |       |   |
| 89.0              | BY    | 8                | 9.0  |                | DEG      |           |      |                | -                  |          |              | 00            | NM           | FRI          | MC       | 75  | 0 1  | MV         | AL         | TI   | TUD   | E.  |
| 40. ANGULAR RES   |       |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            |            |  |       |   |
| 0.17              | DE    | $\overline{G 1}$ | • 5  | NM             | PER      | ? Т       | ٧    | LIN            | E                  | ΔΤ       | CE           | NT            | ER           | FR           | MC       | 75  | 0 1  | NM         | Al         | TI   | TUD   | E   |
| 42. POINTING ACCL | JRACY | 43. P            | OINT | ING            | RATE     |           |      | 44.            | ALT                | ITU      | DE           | -             |              |              | INC      |     |  |            |            |  |       |   |
| 0.5               | DEG   |                  |      |                |          |           |      | ME             | D                  | C        | TRO          | UL            | ΔR           | <u>S1</u>    | JN-      | SY  | NC1  | H R        | ξE         | rro  | GRA   | DE  |
| 46. SPECIAL RE    | QUIR  | EMEN             | NTS  |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            |            |  |       |   |
|                   |       |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            |            |  |       |   |
| 47. COMPONEN      |       |                  |      |                |          |           |      |                |                    |          |              |               |              | -            |          | ~ = | × •  | ·          |            | <del></del>                                      |       |   |
| 2 TV CAM          |       |                  |      | MS,            | , 2      |           |      |                |                    |          |              |               | SYS          |              |          |     |  |            |            |  |       |   |
| 48. WEIGHT        |       | OLUN             | AE . |                |          | 50.       |      |                |                    |          | •—           | TAN           | OBY PO       | WER          | 52.      | PEA | KPU  | JMF        | <u>"  </u> | 53.  | MTBF  |   |
| 43 LB             | L     | MAGNE            | TIC  | т              | MI       | NCI E A S |      | 6 W            |                    | _        | 1            |               | Tee          | 01 115       |          |     |  |            |            |  |       |   |
| 54. INTERFERENCE  | _     | MAGNE<br>NTERFER |      | <del>,  </del> | 56. INTE | RFEREN    | NCE  |                | <sup>57.</sup> INT | ERFE     | IAL<br>RENCE |               |              | SHIE         |          |     | CH   | TEI        | 0          | ENIC   |       |   |
| 59. CALIBRATIO    |       | E11/2            | ITI  | V E            |          | 1.        | SO 5 | ATA            | DE                 | COV      | EDV          |               | 171 /        | (CIVI        |          |     |  |            |            |  | VATIO | <u>,                                     </u> |
| GRAY SCA          |       | CAL              | TRO  | ΛΤΙ            | I O N    |           |      |                |                    |          |              |               | TRY          | <del>,</del> |          |     |  |            | ·          |  | RBI   |   |
| 62. TELEMETR      |       |                  |      |                | UN       |           | UE   | _ ^ 1          | LU                 |          | <u></u> [    | _ <u>13 C</u> | 101          |              | 1 -      |     | J 1 (  | <u> </u>   | <u> </u>   |  | 1     | •   |
| RECORDER          |       |                  |      |                | BACK     | ( ()      | N I  | CDA            | S                  | TΔ       | TIC          | )N            | COM          | ΜΔ           | חע       | VI  | Α .  | THE        |            | SPA  | CF-   |   |
| CRAFT 23          |       |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            |            |  |       |   |
| OF PICTU          |       | _                | •    |                |          |           | -    |                |                    |          |              |               | . •          | ***          |          |     | •  |            | -          |  |       |   |
| 63. ADVANTAG      |       |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          | _   |  |            |            |  |       |   |
| CAMERA M          | OUN.  | TIN              | G A  | LLC            | ) W S    | PΙ        | CT   | JR E           | S                  | TO       | BE           | T             | AKE          | N :          | STR      | AI  | GH'  | <b>T</b> 0 | 100        | ۸N,  | MI    | NI-   |
| MIZING D          | IST   | ORT              | ION  | A١             | ND I     | I N C     | RE.  | ASI            | NG                 | Α        | CCU          | JR A          | CY.          |              |          |     |  |            |            |  |       |   |
| 64. REFERENC      | ES    |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            |            |  |       |   |
| 1)FINAL           | ENG   | INE              | ERI  | NG             | REP      | OR        | T    | ros            | A                  | •        | VOL          | _ 1           | ,2,          | 3.           | RC       | Α   | AS'  | TRO        | 3 – 8      | ELE  | CTR   | 0N-   |
| ICS, CON          |       |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            |            |  |       |   |
| SPACE AP          |       |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            |            |  |       |   |
| O.: REVI          |       |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            |            |  | ME    | -   |
| TEOROLOG          |       |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            | R          | JM   |       |   |
| NATIONAL          |       |                  |      | REC            | ORL      | ) S       | CII  | <del>' (</del> | <u>F 2</u>         | <u> </u> | ),           | AS            | HE V         | ILI          | <u> </u> | N   | <u>. U</u>                                       | •          |            |  |       |   |
| 65. HISTORICA     |       |                  |      | 0110           |          |           |      | 250            | AT                 | <u> </u> | A . A .      |               | <b>A</b> 1 C | - C C        |          |     |  | 1 1/0      |            | `  |       |   |
| TEST FLO          | M M I | UN               | NIM  | RUS            | <u> </u> | 2;        | U    | PEK            | AI                 | 10       | NAL          | <u>. U</u>    | N E          | 33           | 4 3      | , , | • •  | ANU        | ,          | <del>y                                    </del> |       |   |
| ļ                 |       |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            |            |  |       |   |
|                   |       |                  | •    |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            |            |  |       |   |
|                   |       |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            |            |  |       |   |
|                   |       |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            |            |  |       |   |
| ļ                 |       |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            |            |  |       |   |
| 1                 |       |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            |            |  |       |   |
|                   |       |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            |            |  |       |   |
| į                 |       |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            |            |  |       |   |
| ļ                 |       |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            |            |  |       | ·   |
| ]                 |       |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            |            |  |       |   |
|                   |       |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            |            |  |       |   |
| 1                 |       |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            |            |  |       |   |
| ]                 |       |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            |            |  |       |   |
|                   |       |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            |            |  |       | _   |
|                   |       |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            |            |  |       |   |
| }                 |       |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            |            |  |       |   |
| 1                 |       |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            |            |  |       | ĺ   |
|                   |       |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          |     | •  |            |            |  |       |   |
| 1                 |       |                  |      |                |          |           |      |                |                    |          |              |               |              |              |          |     |  |            |            |  |       |   |

| 1. TITLE             |                 |        |                 |              |                   |                  | 2. AC                                 | CRONYM   | 3.  | EXP NO          |
|----------------------|-----------------|--------|-----------------|--------------|-------------------|------------------|---------------------------------------|----------|-----|-----------------|
| ADVANCED             | VIDICON CA      | MERA   | SYSTEM          |              |                   |                  | AVC                                   | . S      |     |                 |
| (TITLE CONT          | Г.)             |        |                 | <del>-</del> |                   |                  | 4. RES                                | UME DATE |     | 5.<br>VERSION   |
|                      |                 |        |                 |              |                   |                  | 097                                   | 701/7    | 2   | 0005            |
| 6. PRINCIPAL         | INVESTIGATOR    | 7. OF  | RGANIZATION     |              |                   | 8. T             | ELEPHON                               | E        |     |                 |
| ALBERT,              | J.              | NES    | C/NOAA          |              |                   | 202              | 2-655-                                | -4700    |     |                 |
| 9. CO-INVESTI        | GATOR           | 10. OF | RGANIZATION     |              |                   | 11. T            | ELEPHON                               | 1E       |     |                 |
|                      |                 |        |                 |              |                   |                  |                                       |          |     |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NU | MBER   | 14. FLASH INDEX | NUMBER       | 15. START<br>DATE | 16. <sup>C</sup> | OMPLETION 1                           | 7. STA1  | rus |                 |
|                      |                 |        |                 |              |                   |                  | ţ                                     | OST      | FL  | IGHT            |
| 18. MONITOR          |                 | 19. AC | GENCY           | 20. PGM      | OFFICE            | 21. 1            | FELEPHO                               | NE       |     |                 |
| GLOVER,              | J.C.            | NES    | C/NOAA          |              |                   | 202              | 2-655-                                | -4CO/    | `   |                 |
| 22. VENDOR           |                 |        | 23. LOCATION    |              |                   |                  | 24 FLIGHT<br>DATE                     | 25. L    | EAD | TIME            |
| PCA ASTR             | G-ELECTRONI     | CS     | PRINCETON,      | N. J.        | •                 |                  | 02/69                                 | 9        |     |                 |
| 26. INSTRUME         | NT TYPE         |        |                 |              |                   |                  |                                       |          |     | 27.<br>SECURITY |
| IMAGER,              | 1-INCH WIDE     | -ANGL  | E HIGH-RESOL    | LUTION       | OIV V             | I COM            | V                                     |          |     | UNC             |
| 28. APPLICATI        | ON              | •      |                 | 2            | 9. SPACE          | CRAF             | Т                                     |          |     |                 |
| MET, ERS             | P               |        |                 | 1            | SSA-              | 9 .              |                                       |          |     |                 |
| 30. PURPOSE          |                 |        |                 |              |                   |                  | · · · · · · · · · · · · · · · · · · · |          |     |                 |

PRIMARY-TO PROVIDE METEOROLOGICAL DATA IN THE FORM OF WIDE-ANGLE HIGH-RESOLUTION TELEVISION PICTURES OF EAPTH'S CLOUD COVEP; BY TRANSMITTING PRERECOFDED TV PICTURES TO CDA STATIONS.\*\*\*
SECONDARY- TO MAINTAIN OPERATIONAL CAPABILITY OF THE AVCS

### 31. PRINCIPLES OF OPERATION

THE AVCS, SCHEDULED FOR FLIGHT ON TOS G AND E, WAS TEST FLOWN ON NIMBUS 1 AND 2 AND OPERATIONALLY ON ESSA 3 AND 5. ALL ARE SIMI-LAR EXCEPT FOR DIFFERENT CAMERA LENSES. THE ESSA/TOS SPACECPAFT HAVE 2 CAMERAS WHILE NIMBUS HAD 3. THE ESSA/TOS SYSTEM CONSISTS OF 2 IDENTICAL 1-INCH VIDICONS HAVING 833-TV-LINE RESOLUTION. THE CAMERAS ARE MOUNTED 180 DEGREES APART ON THE SIDE OF THE SPACECRAFT AND PERPENDICULAR TO THE SPIN AXIS. DURING PICTURE TAKING SEQUENCE THE CAMERA LOOKS AT THE NADIR. THE LENS IS A TEGA-KINOPTIC 108-DEGREE WIDE-ANGLE LENS WITH A FOCAL LENGTH OF 6.0 MM AND AN ELECTROMAGNETICALLY CONTROLLED SHUTTER. THE CAMERA CONVERTS THE OPTICAL IMAGE TO AN ELECTRICAL SIGNAL WHICH IS PRO-CESSED AND RECOPDED ON A MAGNETIC TAPE RECORDER. THE VIDICON HAS AN INHERENT STOKAGE PROPERTY WHICH PERMITS A NOMINAL 6.5 SECOND FRAME SCAN TIME. CONCURRENT WITH SHUTTER ACTUATION A 16-INCRE-MENT GRAY SCALE IS INCLUDED AT THE EDGE OF EACH PICTURE FRAME AS A CONTRAST CHECK. THE CAMERA IS INDEPENDENTLY TRIGGERED INTO OPERATION ONLY WHEN IT COMES IN VIEW OF THE EARTH. THE 4 TRACK MAGNETIC TAPE RECORDER CAN STORE UP TO 36 PICTURES. EACH CAMERA CAN TAKE 6 OR 12 CLOUD COVER PICTURES PER ORBIT AT 260-SECOND INTERVALS WITH A 50 PERCENT OVERLAP.

### 32. PHENOMENA OBSERVED

CLOUD COVER OF EARTH (REFLECTED VISIBLE SOLAR PADIATION)

### 33. MEASUREMENT RANGE

DYNAMIC PANGE OF 14 TO 11,400 FOOT-LAMBERTS

### 34. PRECISION AND ACCURACY

833-LINE RESOLUTION, 16 LEVELS OF GRAY

| 35. SPECTRAL RANGE                            |                       | 36. SPECTRA              | L RESOLUTION    | 37. TIME CONSTANT     |
|---|-----------------------|--------------------------|-----------------|-----------------------|
| 0.45 TO 0.65                                  | MICRON                | NA                       |                 | 47. MILLSEC           |
|   | . GROUND SWA          |                          | :               |                       |
| <u> </u>                                      | 1700 NM B             | Y 1700 N                 | M FROM 75       | O NM ALTITUDE         |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION | UTION                 |                          |                 |                       |
| 0.17 DEG 1.5 NM PER                           | TV LINE               | AT CENTE                 | ER FROM 75      | O NM ALTITUDE         |
| 42. POINTING ACCURACY 43. POINTING RATE       | 44. ALT               | TUDE                     | 45. INCLINA     | TION                  |
| ∩•5 DEG                                       | MED                   | CIRCUL                   | R SUN-SY        | NCH RETROGRADE        |
| 46. SPECIAL REQUIREMENTS                      |                       |                          |                 |                       |
|   |                       |                          |                 |                       |
| 47. COMPONENTS                                |                       |                          |                 |                       |
| 2 TV CAMERA SYSTEMS, 2 T                      | APE RECO              | RDERS, S                 | SYSTEM ELE      | CTRONICS              |
|   |                       |                          | Y POWER 52. PEA | K POWER 53. MTBF      |
| 43 LB   | 16 WAT                |                          |                 |                       |
| 54. INTERFERENCE 55. MAGNETIC 56. NUCLI       | EAR<br>RENCE 57. INTE | HERMAL<br>RFERENCE       | 58. SHIELDING   |                       |
| SENSITIVE                                     | <u> </u>              |                          | <del></del>     | SHIFLDING USED        |
| 59. CALIBRATION                               | 60. DATA REC          |                          |                 | QUENCY OF OBSERVATION |
| GRAY-SCALE CALIBRATION                        | DEL AYED              | TELEMET                  | TRY DAY         | SIDE OF DRBIT         |
| 62. TELEMETRY REQUIREMENTS                    |                       |                          |                 |                       |
| RECORDER IS PLAYED BACK                       |                       |                          |                 |                       |
| CRAFT 235-MHZ TRANSMITTE                      |                       | MISSION                  | TIME FOR        | A FULL ORBIT          |
| OF PICTURES IS APPROX 3                       | MINUTES.              |                          |                 |                       |
| 63. ADVANTAGES AND LIMITATIONS                |                       |                          |                 |                       |
| CAMERA MOUNTING ALLOWS P                      |                       |                          |                 | GHT DOWN, MIMI-       |
| MIZING DISTORTION AND IN                      | ICREASING             | ACCURAC                  | Υ.              |                       |
| 64. REFERENCES                                |                       |                          |                 |                       |
| 1) FINAL ENGINEERING REPO                     |                       |                          |                 |                       |
| ICS, CONTRACT NO. NAS 5-                      |                       |                          |                 |                       |
| SPACE APP 1966. NASA SP-                      |                       |                          |                 |                       |
| O.: PEVIEW OF A DECADE C                      |                       |                          |                 |                       |
| METEOROLOGY. NASA/GSFC,                       | AUG. 196              | 8 • <del>*</del> * * 4 ) | DATA AVAII      | LABLE FROM NA-        |
| TIONAL WEATHER RECORDS C                      | TH CESSA              | , ASHEV                  | ILLE, N.C.      |                       |
| 65. HISTORICAL REMARKS                        | 5664 2 5              | 4.00 =                   |                 |                       |
| FLOWN ON NIMBUS 1,2 AND                       | ESSA 3.5              | AND 7.                   |                 |                       |
|   | •                     |                          |                 | İ                     |
|   |                       |                          |                 |                       |
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| 1. TITLE             |                   |        |                   |        |                   |               | 2                 | ACRONYM    | 3.1 | EXP NO          |  |
|----------------------|-------------------|--------|-------------------|--------|-------------------|---------------|-------------------|------------|-----|-----------------|--|
| ADVANCED             | VIDICON CAME      | RA S   | SYSTEM            |        |                   |               | Α١                | /CS        |     |                 |  |
| (TITLE CONT.         | )                 |        | -                 |        |                   |               | 4. R              | ESUME DATE |     | 5.<br>VERSION   |  |
|                      |                   |        |                   |        |                   |               | 0.9               | 7017       |     | 2006            |  |
| 6. PRINCIPAL II      | VVESTIGATOR       | 7. OR  | SANIZATION        |        |                   | 8. T          | ELEPHO            | NE         |     |                 |  |
| OBRIEN.              | J. (T.MON)        | GODE   | DARD SPACE F      | LTC    | ENTER             | 30:           | -982              | -504       | 2   |                 |  |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION        |        |                   | 11. TELEPHONE |                   |            |     |                 |  |
|                      |                   |        |                   |        |                   |               |                   |            |     |                 |  |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX N | UMBER  | 15. START<br>DATE | 16. C         | OMPLETION<br>DATE | 17. STA    | TUS |                 |  |
| CPFF                 |                   |        |                   |        |                   |               |                   | INTE       | GRA | TION            |  |
| 18. MONITOR          |                   | 19. AG | ENCY              | 20. PG | M OFFICE          | 21. 1         | ELEPH             | ONE        |     |                 |  |
| GARBACZ,             | M.L.              | NASA   | HDQTRS            | DA     | 'ERO              | 202           | 2-755             | -232       | 2   |                 |  |
| 22. VENDOR           |                   |        | 23. LOCATION      |        |                   |               | 24. FLIGHT        | 7 25. L    | EAD | TIME            |  |
| RCA ASTRO            | D-ELECTRONICS     | 5      | PRINCETON,        | N.J.   | •                 |               | 1/70              |            |     |                 |  |
| 26. INSTRUMEN        | T TYPE            |        |                   |        |                   |               |                   |            |     | 27.<br>SECURITY |  |
| IMAGER, H            | HIGH-RESOLUTI     | ON V   | IDE-ANGLE 1       | -INC   | DIV H             | I COI         | V CAN             | 1ERA       |     | UNC             |  |
| 28. APPLICATIO       | N                 |        |                   |        | 29. SPACE         | CRAF          | T                 |            |     |                 |  |
| MET, ERSF            |                   |        |                   |        | I TOS-            | 1             |                   | -          |     |                 |  |
| 30. PURPOSE          |                   |        |                   |        |                   |               |                   |            |     |                 |  |
|                      |                   |        |                   |        |                   |               |                   |            |     |                 |  |

PRIMARY-TO PROVIDE METEOROLOGICAL DATA IN THE FORM OF WIDE-ANGLE HIGH-RESOLUTION TELEVISION PICTURES OF EARTH'S CLOUD COVER.\*\*\*
SECONDARY-TO MAINTAIN OPERATIONAL CAPABILITY OF THE AVCS.

### 31. PRINCIPLES OF OPERATION

THE AVCS FOR TIROS M IS BASICALLY SIMILAR TO THE SYSTEMS TEST FLOWN ON NIMBUS 1 AND 2 AND OPERATIONALLY FLOWN ON FSSA 3 AND 5. THE TIROS M SYSTEM CONSISTS OF 2 IDENTICAL 1-IN VIDICONS HAVING 833 TV LINE RESOLUTION WITH ONLY 1 IN OPERATION AT ANY GIVEN TIME. THE CAMERAS ARE MOUNTED ON THE BASEPLATE OF THE SPACECRAFT AND LOOK AT THE NADIR DURING PICTURE-TAKING SEQUENCES. THE LENS IS A TEGEA-KINOPTIC, 108 DEG, WIDE-ANGLE, F/1.8, 5.7 MM LENS USING AN ELECTROMAGNETICALLY CONTROLLED SHUTTER. THE VIDICON IS A "HYBRID VIDICON" WHICH IS ELECTROSTATICALLY FOCUSED AND MAG-NETICALLY DEFLECTED. IT HAS AN INHERENT STORAGE PROPERTY WHICH PERMITS A NOMINAL 6.5 SEC FRAME SCAN TIME. A GRAY-SCALE CALIBRA-TOR ASSEMBLY, UTILIZING AN INCANDESCENT LAMP AS A LIGHT SOURCE. PROVIDES 15 LINEAR DENSITY STEPS. THE LIGHT OUTPUT IS DIRECTED THROUGH THE GRAY-SCALE TRANSPARENCY BY MEANS OF A LENS AND PRISM ARRANGEMENT AND IMPRESSED ON THE VIDICON PHOTO CONDUCTOR. THE GRAY-SCALE SERVES AS A REFERENCE WHEN THE TV PICTURES ARE PRO-CESSED ON THE GROUND. A COMPLETE PICTURE SEQUENCE LASTS ABOUT 48 MIN. DURING WHICH 11 PICTURES ARE TAKEN AT INTERVALS OF 260 SEC (GIVING AN OVERLAP OF 50 PERCENT) AND STORED IN A 3-CHANNEL TAPE RECORDER FOR LATER TRANSMISSION.

### 32. PHENOMENA OBSERVED

CLOUD COVER OF EARTH (REFLECTED VISIBLE SOLAR RADIATION)

33. MEASUREMENT RANGE

DYNAMIC RANGE OF 200 TO 10,000 FOOT-LAMBERTS

34. PRECISION AND ACCURACY

833-LINE RESOLUTION, 15-16 LEVELS OF GRAY

|  |  | OT THE CONCTANT  |
|--|--|--|
| 35. SPECTRAL RANGE                                     |  | 37. TIME CONSTANT  |
| 0.4 TO 0.65 MIC  | the same and the s | 9.5 SEC  |
| 38. FIELD OF VIEW 39. GROUN                            | The state of the s |  |
|  | NM BY 1700 NM FROM 75  | O NM ALTITUDE  |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION          |  |  |
| 0.13 DEG 1.7 NM PER TV-L                               | INE AT THE CENTER FROM   |  |
| 42. POINTING ACCURACY 43. POINTING RATE 4              | 4. ALTITUDE 45, INCLINA  | to the second se |
| NA   | MED CIRCULAR SUN-SY  | NCH RETROGRADE   |
| 46. SPECIAL REQUIREMENTS                               |  |  |
|  |  |  |
| 47. COMPONENTS   | 4  | S STATE OF THE PROPERTY OF THE |
| 2 TV CAMERAS, 2 TAPE RECORDE                           | RS, SYSTEM ELECTRONIC  | S  |
| 48. WEIGHT 49. VOLUME 50. AVERA                        | GE POWER 51. STANDBY POWER 52. PEAL  | K POWER 53. MTBF   |
| 63 LB 3.5 CU FT 9                                      | WATTS 210  | WATTS 1 YEAR   |
| 54- INTERFERENCE 55. MAGNETIC 56. NUCLEAR INTERFERENCE | 57. THERMAL 58. SHIELDING  |  |
| SENSITIVE  |  | SHIELDING USED   |
| 59. CALIBRATION 60. DA                                 | TA RECOVERY 61. FREC   | QUENCY OF OBSERVATION  |
| GRAY-SCALE CALIBRATION DEL                             | AYED AND REALTIME DAY  | SIDE OF ORBIT  |
| 62. TELEMETRY REQUIREMENTS                             |  |  |
| THE AVCS VIDEO SIGNAL HAS A                            | BASEBAND OF 60 KHZ, W  | ITH ITS DATA   |
| MADE UP OF DISCRETE FRAMES.                            |  |  |
| 1,1702 01 31 32301 212 11111                           |  |  |
| 63. ADVANTAGES AND LIMITATIONS                         | and the comment of th |  |
| PROVIDE WIDE ANGLE VIEWING A                           | T MODERATELY HIGH RESI   | OLUTION .  |
| PROVIDE WIDE ANGLE VIEWING A                           | , ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,  |  |
| 64. REFERENCES   | and the second s |  |
| 1) DESIGN STUDY REPORT FOR TH                          | E IMPROVED TOS (ITOS)  | SYSTEM. V.1-3.   |
| RCA ASTRO-ELECTRONICS, CONTRA                          |  |  |
| RCA ASTRU-ELECTRUNICS, CUNTRA                          | U NU. NASS-9034; JUN   | CTRONICS DIV   |
| ENGINEERING REPORT TOS A.VOL                           | 1,2,3. KUA ASTRUMELE   | CIRUNICS DIV.  |
| CONTRACT NO. NASS-9034, MAY                            | 5,1967. *** 31 ESSA PRE  | SS RELEASE FUR   |
| ESSA 3, ES 66054, SEPT. 19,                            |  | V. IN SPACE  |
| APP. 1966, NASA SP-156, 1967                           |  |  |
| 65. HISTORICAL REMARKS                                 |  |  |
| SIMILAR TO AVCS ON NIMBUS 1                            | AND 2, AND ESSA 3 AND  | .5•  |
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| 1. TITLE                              |               |          |        |      |                   |     |        |           |       |              |           | ONYM                                    | 3. | EXP NO          |
|---------------------------------------|---------------|----------|--------|------|-------------------|-----|--------|-----------|-------|--------------|-----------|---|----|-----------------|
| ADVANCED                              | VIDICON CAME  | RA S     | YST    | EM   |                   |     |        |           |       | /            | VC        | S                                       |    |                 |
| (TITLE CONT.                          |               |          |        |      |                   |     |        |           |       |              | 4. RESUI  | WE DATE                                 |    | 5.<br>VERSION   |
|                                       |               |          |        |      |                   |     |        |           |       | (            | 9/        | 01/7                                    | 72 | 2005            |
| 6. PRINCIPAL II                       | NVESTIGATOR   | 7. OR    | GANIZ  | ATIC | N                 |     |        |           | 8. T  | ELEPI        | HONE      |   |    |                 |
| BEBRIS, .                             | J •           | GODE     | ) AR D | SF   | ACE               | FL  | T C    | ENTER     | 30    | 1-98         | 32-       | 5042                                    | 2  |                 |
| 9. CO-INVESTIG                        |               | 10. OR   | GANIZ  | ATIC | N                 |     |        |           | 11. T | ELEP         | HON       | =                                       |    |                 |
| BURDETT, G.L. GODDARD SPACE FLT CENTE |               |          |        |      |                   |     |        |           |       |              | 5042      |   |    |                 |
| 12. CONTRACT<br>TYPE                  | LASH          | INDE     | X NU   | MBER | 15. START<br>DATE | 16. | OMPLET | ON 17     | .STA1 | rus          |           |   |    |                 |
|                                       |               |          |        | _    |                   |     |        |           |       |              | P         | OST                                     | FL | IGHT            |
| 18. MONITOR                           |               | 19. AG   | ENCY   |      |                   |     | 20. PG | M OFFICE  | 21.   | TELEF        | HON       | E                                       |    |                 |
| TEPPER, M                             | М.            | NASA     | A HD   | QTR  | S                 |     | OA/    | ERD_      | 20    | 2-7          | 55-       | 2322                                    | 2  |                 |
| 22. VENDOR                            |               |          | 23. L  | OCA  | TION              |     |        |           |       | 24. FL<br>DA | GHT<br>TE | 25. L                                   | EA | D TIME          |
| RCA ASTRO                             | D-ELECTRONICS | <u> </u> | PRI    | NCE  | TON               | , N | l.J.   |           |       | 08.          | 164       | NA                                      |    |                 |
| 26. INSTRUMEN                         | IT TYPE       |          |        |      |                   |     |        |           | •     |              |           | .,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, |    | 27.<br>SECURITY |
| IMAGER,                               | 1-INCH WIDE-A | NGLE     | нІ     | GH-  | RES               | OLL | JTIO   | N VID     | ICO   | N            |           |   |    | UNC             |
| 28. APPLICATIO                        | N ·           |          |        |      |                   |     |        | 29. SPACE | CRAF  | T            |           |   |    | *               |
| MET                                   |               |          |        |      |                   |     |        | NIMBU     | S 1   |              |           |   |    |                 |
| 30. PURPOSE                           |               |          |        |      |                   |     |        |           |       |              |           |   |    |                 |

PRIMARY-TO OBSERVE THE ENTIRE DAYTIME CLOUD COVER OF THE EARTH ONCE A DAY FOR METEOPOLOGICAL RESEARCH PURPOSES. \*\*\*SECONDARY-TO TEST THE SYSTEM IN SPACE PRIOR TO APPLICATION IN AN OPERATIONAL SPACECRAFT SYSTEM.

### 31. PRINCIPLES OF OPERATION

THE AVCS TEST FLOWN ON NIMBUS 1 AND 2 AND OPERATIONALLY ON FSSA 3 AND 5 ARE SIMILAR EXCEPT FOR THE LENS USED AND NIMBUS HAVING 3 CAMERAS TO ESSA'S 2. ON NIMBUS THE 3 VIDICON CAMERAS ARE DEPLOY-ED IN A FAN-LIKE ARRAY TO PRODUCE A 3-SEGMENT COMPOSITE PICTURE. EACH CAMERA COVERS A 37-DEG FOV WITH THE CENTER CAMERA POINT-ING STRAIGHT DOWN. THE OPTICAL AXIS OF THE OTHER 2 UNITS ARE RO-TATED 35 DEG TO EITHER SIDE OF LOCAL VERTICAL. A 3-PICTURE SET IS TAKEN EVERY 91 SECS AND COVERS AN AREA OF APPROX 400.000 SO MI WITH 96 PICTURES PER ORBIT ACQUIRED. THE PICKUP TUBES ARE 833 SCANLINE, 1-IN DIAM VIDICONS GIVING A LINEAR RESOLUTION OF ABOUT 0.5 NM AT THE OPTICAL CENTER AT 575 NM ALT. EACH OF THE 3 CAM-ERAS EMPLOY A 17 MM F/4 LENS WITH A SERVOCONTROLLED IRIS FOR EX-POSURE ADJUSTMENT. SHUTTER SPEED IS SET AT 40 MILLISEC EXPOSURE TIME. A POTENTIOMETER ATTACHED TO THE SOLAR ARRAY CONTROLS THE LENS OPENING FROM F/16 WHEN THE SPACECRAFT IS OVER THE EQUATOR TO F/4 WHEN THE S/C IS NEAR THE POLES. THE CAMERAS ARE PROGRAM-MED TO UPERATE ONLY AT A SUN ANGLE OF HIGHER THAN 85 DEG. A TAPE RECORDER WITH 1200 FT OF TAPE WILL RECORD 2 COMPLETE ORBITS OF 192 PICTURES. THESE VIDEO SIGNALS ARE TRANSMITTED TO THE GROUND IN 4 MIN USING THE 1707.5 MHZ TRANSMITTER

### 32. PHENOMENA OBSERVED

CLOUD COVER OVER THE EARTH'S SURFACE

### 33, MEASUREMENT RANGE

DYNAMIC RANGE OF 14 TO 11400 FOOT-LAMBERTS

### 34. PRECISION AND ACCURACY

8-10 LEVELS OF GRAY, 833 LINE RESOLUTION

| 35. SPECTRAL RANGE                    |  | 36. SPECTRAL RESO  | LUTION   | 37. TIME CONSTANT  |
|---------------------------------------|--|--|--|--|
| 0.45 TO 0.6                           | 5 MICRON   | NA   |  |  |
| 38. FIELD OF VIEW                     | 39. GROUND SW  |  | *  |  |
| L                                     |  | AM CIRCLE FR   | DM 601   | O NM ALTITUDE  |
| 40. ANGULAR RESOLUTION 41. SPATIAL RE | A STATE OF THE STA |  |  |  |
| 0.05 DEG 0.5 NM A                     |  |  |  | PH   |
| 42. POINTING ACCURACY 43. POINTING RA |  | The second secon | . INCLINA  | The second secon |
|                                       | MED  | CIRCULAR S   | UN-SY  | NCH RETROGRADE   |
| 46. SPECIAL REQUIREMENTS              |  |  |  | A CONTRACTOR OF THE PARTY OF TH |
| 47. COMPONENTS                        |  |  |  |  |
| 3 VIDICON CAMERAS, AS                 | SOCIATED EL  | FCTRONICS  |  | to the second section of the section of the second section of the second section of the second section of the section of the second section of the section o |
| 48. WEIGHT 49. VOLUME                 | 50. AVERAGE POV  | A CONTRACTOR OF THE CONTRACTOR | 52. PEAI   | K POWER 53. MTBF   |
| 63 LB                                 | 27 WAT   |  | A STATE OF THE STA | 12 MON   |
| 54 INTERFERENCE 55 MAGNETIC 56.       | NUCLEAR 57. IN   | THERMAL 58. SHI  | ELDING   |  |
| SENSITIVE                             |  | and the contraction of the contr | ETIC :   | SHIELDING USED   |
| 59. CALIBRATION                       | 60. DATA RE  |  |  | QUENCY OF OBSERVATION  |
| GRAY-SCALE CALIBRATOR                 | DELAYED  | TELEMETRY  | CON  | TINUOUS DAYTIME  |
| 62. TELEMETRY REQUIREMENTS            |  |  |  |  |
| NIMBUS S-BAND TRANSMI                 |  | · ·  |  | SIGNAL TO  |
| GROUND STATION USING                  | THE 1707.5   | MHZ FREQUENC   | Υ.   |  |
|                                       | And the second s |  |  | www.communications.com   |
| 63. ADVANTAGES AND LIMITATIONS        |  |  |  | 1  |
|                                       |  |  |  |  |
|                                       |  |  |  | www.miningreet.com   |
| 64. REFERENCES  1) SIG ACHIEV IN SAT  | VET 1050-10  | 45 MACA CO.  | 06 443   | YON TAICTPUMENTS   |
| AND SPACECRAFT OCT 57                 |  |  |  | · · ·  |
| CATALOG: AVCS AND APT                 | •  |  |  |  |
| CADE OF SPACE CAMERA                  | •  |  | -  |  |
| SYMP SOC PHOTO-OPTICAL                |  |  |  | _  |
| AVAILABLE FROM NATION                 |  |  |  |  |
| 65. HISTORICAL REMARKS                |  |  | 9  |  |
| SIMILAR TO AVCS ON NI                 | ABUS 2, ESS  | A 3, AND ESS   | A 5.   |  |
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| 1. TITLE  |               |        |               |         |           |       |                   |             |      |               |  |
|---|---------------|--------|---------------|---------|-----------|-------|-------------------|-------------|------|---------------|--|
| ADVANCED  | VIDICON CAM   | ERA S  | SYSTEM        |         |           |       | Α                 | VC S        |      |               |  |
| (TITLE CONT.  | )             |        |               | 7       |           |       | 4,1               | RESUME DATE |      | 5.<br>VERSION |  |
|   |               |        |               |         |           |       | 0                 | 9/01/       | 72   | 0005          |  |
| 6. PRINCIPAL II   | NVESTIGATOR   | 7. OR  | GANIZATION    |         |           | 8. TI | ELEPHO            | ONE         |      |               |  |
| ARL AUSKA   | S, J.         | GODI   | DARD SPACE FL | _T C    | ENTER     | 300   | 1-98              | 2-504       | 2    |               |  |
| 9. CO-INVESTIG  | ATOR          | 10. OR | GANIZATION    |         |           | 11. T | ELEPHO            | ONE         |      |               |  |
|   |               |        |               |         |           |       |                   |             |      |               |  |
| 12. CONTRACT NUMBER 14. FLASH INDEX NUMBER 15. START DATE |               |        |               |         |           |       | OMPLETION<br>DATE | 17. STA     | TUS  |               |  |
|   |               |        |               |         |           |       |                   | POST        | FI   | LIGHT         |  |
| 18. MONITOR   |               | 19. AG | ENCY          | 20. PGA | OFFICE    | 21. T | ELEPH             | ONE '       | *    |               |  |
| HALEY, DI   | R. R.         | NAS    | A HDQTRS      | OA/     | ERN       | 20    | 2-75              | 5-232       | 2    |               |  |
| 22. VENDOR  |               | ,      | 23. LOCATION  |         |           |       | 24. FLIGH<br>DATE | ¹ 25. I     | .EAI | D TIME        |  |
| RCA ASTR  | O-ELECTRONICS | S      | PRINCETON, N  | ۱.J.    |           |       | 05/               | 66          |      |               |  |
| 26. INSTRUMEN   | TTYPE         |        |               |         |           |       |                   |             |      | 27. SECURITY  |  |
| IMAGER,   | 1-INCH WIDE-  | ANGL   | E HIGH-RESOLU | OITL    | N VID     | I CO  | V                 |             |      | UNC           |  |
| 28. APPLICATIO  | N .           |        |               |         | 29. SPACE | CRAF  | T                 |             |      |               |  |
| MET   |               |        |               |         | NIMBU     | S 2   |                   |             |      |               |  |
| 30. PURPOSE   | •             |        |               |         |           |       |                   |             |      |               |  |

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### 32. PHENOMENA OBSERVED

CLOUD COVER OVER THE EARTH'S SURFACE

### 33. MEASUREMENT RANGE

DYNAMIC RANGE OF 14 TO 11.400 FOOT-LAMBERTS

### 34. PRECISION AND ACCURACY

8-10 LEVELS OF GRAY, 833 LINE RESOLUTION

| 35. SPECTRAL F    | LANG        |   |              |                |             | 36. SP             | ECTRA    | L RES     | SOLL            | ITION   | 37. TIME  | CONST       | ANT            |
|-------------------|-------------|---|--------------|----------------|-------------|--------------------|----------|-----------|-----------------|---------|-----------|-------------|----------------|
| 0.45              |             |   | . 65         | M T            | CRON        | NA                 | n/       | //61      |                 |         |           |             |                |
| 38. FIELD OF V    |             | - 3                                     |              |                | UND SWA     |                    |          |           |                 |         |           | <del></del> |                |
| 37.0              |             |   | 1 -          |                |             |                    | 100      | 1 F       | <u> </u>        | M ( ^   | C NM      | A1 T T      | THOS           |
| 40. ANGULAR RESC  | )) ::-:-    | IN A1 COAT                              |              |                |             | <u> </u>           | LIKE     | <u>eu</u> | , KJ            | in ou   | C NIT     | <u>ntil</u> | 1000           |
| 0.5               |             | G 0.5 NM                                |              |                |             | OM '               | 575      | NIM       | <u> </u>        | ITUD    | E         |             |                |
|                   |             | , · · · · · · · · · · · · · · · · · · · |              | CCIVI          |             |                    | 713      |           |                 |         |           |             |                |
| 42. POINTING ACCU | HACY        | 43. PUINTING                            | MATE         |                | 44. ALTI    |                    | , C i 11 |           |                 | NCLINA  |           | DETE        | 000400         |
| 46 00-            |             | FA453-                                  |              |                | MED         | <u> </u>           | CUL      | 4 K       | <u> </u>        | IN-SY   | NCH I     | KEIK        | OGRADE         |
| 46. SPECIAL RE    | UUIR        | EMENIS                                  | <del>-</del> |                |             |                    |          |           |                 |         |           |             |                |
| L                 |             | <del></del>                             |              |                |             |                    |          |           |                 |         |           |             |                |
| 47. COMPONEN      |             | AMERICA                                 | ACC-         | <del>~ ,</del> | <del></del> |                    | 101-     | ~ ~       |                 |         |           |             | <u></u>        |
| 3 VIDICO          | ,           | <del></del>                             | #22 <u>0</u> |                |             |                    |          |           |                 | =====   | V 60:     | T = -       |                |
| 48. WEIGHT        |             | OLUME                                   |              |                | RAGE POWE   |                    | . STAND  | SY POW    | VER             | oz. PEA | K POWER   |             | ATBF           |
| 63 LB             |             | Magnet                                  |              |                | 7 WAT       | 1                  |          |           |                 |         |           | 1 1         | 2 MON          |
| 54. INTERFERENCE  |             | MAGNETIC<br>NTERFERENCE                 | 56. NUCI     | ERENCE         | 57. INTE    | HERMAL<br>RFERENCI | E        |           |                 | DING    |           |             |                |
|                   |             | ENSITIVE                                |              |                |             |                    | ]        | MA        | <u>GNE</u>      |         | SHIEL     |             |                |
| 59. CALIBRATIO    |             |   | _            |                | ATA REC     |                    |          |           |                 |         | DUENCY OF |             |                |
| GRAY-SCA          |             |   | UR           | <u>  DE</u>    | LAYED       | TEL                | .EME     | TRY       |                 | LCON    | TINUO     | US D        | AYTIME         |
| 62. TELEMETRY     |             |   |              |                |             |                    |          |           |                 |         |           |             |                |
| NIMBUS S          |             |   |              |                |             |                    |          |           |                 |         | SIGNA     | L TO        | · <del>-</del> |
| GROUND S          | TAT         | ION USIN                                | G TH         | E 17           | 07.5        | MHZ                | FRE      | QUE       | VC Y            | •       |           |             |                |
|                   | _           |   | :            |                |             |                    |          |           |                 |         |           |             |                |
| 63. ADVANTAG      |             |   |              |                |             |                    |          |           |                 |         |           |             |                |
| IMPROVEM          |             |   |              |                | AVCS        | INP                | ELT      | ABTI      | IT              | Y , P   | ERFOR     | MANC        | E,             |
| AND LIFE          |             |   |              |                |             |                    |          |           | _               | . '     |           |             |                |
| 64. REFERENCE     | ES          |   |              |                |             |                    |          | _         |                 |         |           |             |                |
| 1) SIGNI          | FIC         | ANT ACHI                                | EVEM         | ENTS           | IN S        | ATEL               | LITE     | E MF      | <del>- T.</del> | 195     | 8-1964    | 4. N        | ASA            |
| SP-96.**          | <b>*2</b> ) | INSTRUM                                 | ENTS         | AND            | SPACE       | ECRA               | FT r     | oc r`     | 57              | -MAR    | 65. N     | AZAV        | SP-            |
| 3028.***          | 3)          | NIMBUS 2                                | USF          | R + S          | GUIDE       | . G S              | FC.      | JIII      | Υ .             | 66-*    | **4) f    | )STP        | חאר ח          |
| AND WEIN          | STE         | IN, 0 .:                                | REVI         | EW DI          | FAD         | ECAN               | )E ni    | FSF       | PAC             | E CA    | MERA C    | SYCTI       | EMS            |
| DEVELOPM          |             |   |              |                |             |                    |          |           |                 |         |           |             |                |
| TIONAL W          | EAT         | HER RECO                                | RDS (        | STR            | (ESSA       | ) <b>,</b> A       | SHE      | /11 '     | .F.             | N C     | f         | ii          | · *F*          |
| 65. HISTORICAL    |             |   |              | <del></del>    |             |                    |          |           | <u>- I</u>      |         |           |             |                |
| SIMILAR           |             |   | NIMRI        | JS 1           | . FSC       | 4 2                | ANI      | ) F       | SSA             | 5_      |           |             |                |
|                   |             |   |              |                | 1000        |                    |          |           | <u> </u>        |         | <u> </u>  |             | -              |
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|----------------------|-------------------|--------|--------------------|---------------|-------------------|--------|---------------------|-----------------|-----------------|
| 1. TITLE             |                   |        |                    |               |                   |        | 2. 4                | CRONYM          | 3. EXP NO       |
| ADVANCED             | VIDICON CAM       | ERA :  | SYSTEM             |               |                   |        | Δ١                  | /CS             |                 |
| (TITLE CONT.         | .)                |        |                    |               |                   |        | 4. R                | ESUME DATE      | 5.<br>VERSION   |
|                      |                   |        |                    |               |                   |        | 199                 | 11010           | 72 3006         |
| 6. PRINCIPAL II      | NVESTIGATOR       | 7. OR  | GANIZATION         |               |                   | 8. TI  | ELEPHO              | NE              |                 |
| OBPIEN,              | J. (T.MON)        | GOD    | DARD SPACE F       | LT C          | ENTER             | 30.    | <b>1-</b> 982       | 2-5042          | 2               |
| 9. CO-INVESTIG       | GATOR             | 10. OR | GANIZATION         | •             |                   | 11. T  | ELEPHO              | NE              |                 |
|                      |                   |        |                    |               |                   |        |                     |                 |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | MBER          | 15. START<br>DATE | 16. C  | OMPLETION<br>DATE   | 17. STA1        | rus             |
| CPFF                 |                   |        |                    |               |                   | OPERA  | ATIONAL             |                 |                 |
| 18. MONITOR          |                   | 19. AG | ENCY               | 20. PGN       | OFFICE            | 21. T  | ELEPHO              | ONE             |                 |
| GARBACZ,             | M.L.              | NAS    | A HDQTFS           | DΔ/           | ERO               | 20.    | 2 <del>-</del> 75 : | 5 <u>-232</u> 2 | 2               |
| 22. VENDOR           | ·                 |        | 23. LOCATION       |               |                   |        | 24. FLIGHT<br>DATE  | 25. L           | EAD TIME        |
| RCA ASTR             | O-ELECTRONIC      | S      | PRINCETON,         | N.J.          |                   |        | 127                 | 70 NA           |                 |
| 26. INSTRUMEN        |                   |        |                    |               |                   |        |                     |                 | 27.<br>SECURITY |
| IMAGER,              | HIGH-RESOLUT      | ION    | WIDE-ANGLE 1       | <u>– I NC</u> | H VID             | I C () | V CAN               | 4EPA            | UNC             |
| 28. APPLICATIO       | ON                |        |                    | [2            | 29. SPACE         | CRAF   | T                   |                 |                 |
| MET, ERS             | Р                 |        |                    |               | NOAA-             | -1.    |                     |                 |                 |
| 30. PURPOSE          | •                 |        |                    |               |                   |        |                     | -               |                 |

PRIMARY-TO PROVIDE METEOROLOGICAL DATA IN THE FORM OF WIDE-ANGLE HIGH-RESOLUTION TELEVISION PICTURES OF EAPTH'S CLCUD COVER.\*\*\*
SECONDARY-TO MAINTAIN OPERATIONAL CAPABILITY OF THE AVCS.

### 31. PRINCIPLES OF OPERATION

THE AVCS FOR NOAA-1 IS BASICALLY SIMILAR TO THE SYSTEMS TEST FLOWN ON NIMBUS 1 AND 2 AND OPERATIONALLY FLOWN ON ESSA 3 AND 5 THE NOAA-1 SYSTEM CONSISTS OF 2 IDENTICAL 1-INCH VIDICONS HAVING 833 TV LINE RESOLUTION WITH ONLY 1 IN OPERATION AT ANY GIVEN TIME. THE CAMERAS ARE MOUNTED ON THE BASEPLATE OF THE SPACECRAFT AND LOOK AT THE NADIF DURING PICTURE-TAKING SEQUENCES. THE LENS IS A TEGEA-KINOPTIC, 108 DEG, WIDE-ANGLE, F/1.8, 5.7 MM LENS USING AN ELECTROMAGNETICALLY CONTROLLED SHUTTER. THE VIDICON IS A "HYBRID VIDICON" WHICH IS ELECTROSTATICALLY FOCUSED AND MAG-NETICALLY DEFLECTED. IT HAS AN INHERENT STORAGE PROPERTY WHICH PERMITS A NOMINAL 6.5 SEC FRAME SCAN TIME. A GRAY-SCALE CALIBRA-TOR ASSEMBLY, UTILIZING AN INCANDESCENT LAMP AS A LIGHT SOURCE. PROVIDES 15 LINEAR DENSITY STEPS. THE LIGHT OUTPUT IS DIRECTED THROUGH THE GRAY-SCALE TRANSPARENCY BY MEANS OF A LENS AND PRISM ARRANGEMENT AND IMPRESSED ON THE VIDICON PHOTO CONDUCTOR. THE GRAY-SCALE SERVES AS A REFERENCE WHEN THE TV PICTURES ARE PRO-CESSED ON THE GROUND. A COMPLETE PICTURE SEQUENCE LASTS ABOUT 48 MIN. DURING WHICH 11 PICTURES ARE TAKEN AT INTERVALS OF 260 SEC (GIVING AN OVERLAP OF 5C PERCENT) AND STORED IN A 3-CHANNEL TAPE RECORDER FOR LATER TRANSMISSION.

### 32. PHENOMENA OBSERVED

CLOUD COVER OF EARTH (REFLECTED VISIBLE SOLAR RADIATION)

### 33. MEASUREMENT RANGE

DYNAMIC RANGE OF 200 TO 10,000 FOOT-LAMBERTS

### 34. PRECISION AND ACCURACY

833-LINE RESOLUTION, 15-16 LEVELS OF GRAY

| 25 SPECTRAL BANCE                                   | 26 OPENTRAL DECOLUTION 27 TIME CONSTANT         |
|---|---|
| 35. SPECTRAL RANGE                                  | 36. SPECTRAL RESOLUTION 37. TIME CONSTANT       |
| 0.4 TO 0.65 MICRO<br>38. FIELD OF VIEW [39. GROUND: |   |
|   | BY 1700 NM FROM 750 NM ALTITUDE                 |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION       | DE LIOU NO FROM FOU NO ALITIDUE                 |
|   | E AT THE CENTER FROM 750 NM ALT                 |
|   | ALTITUDE 45. INCLINATION                        |
|   | D CIRCULAR SUN-SYNCH RETROGRADE                 |
| 46. SPECIAL REQUIREMENTS                            |   |
|   |   |
| 47. COMPONENTS                                      |   |
| 2 TV CAMERAS, 2 TAPE RECORDERS                      |   |
|   | POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF |
| 63 LB 3.5 CU FT 9 W                                 | ATTS 210 WATTS 1 YEAR                           |
|   | 77. THERMAL 58. SHIELDING                       |
| SENSITIVE   | MAGNETIC SHIELDING USED                         |
|   | RECOVERY 61. FREQUENCY OF OBSERVATION           |
|   | ED AND REALTIME DAYSIDE OF ORBIT                |
| 62. TELEMETRY REQUIREMENTS                          | CERAND DE 40 VIZ HITH ITC DATA                  |
| IMADE UP DE DISCRETE ERAMES.                        | SEBAND OF 60 KHZ, WITH ITS DATA                 |
| PAREC OF OF SISCRETE FRAMES.                        |   |
| 63. ADVANTAGES AND LIMITATIONS                      |   |
| PROVIDE WIDE ANGLE VIEWING AT                       | MODERATELY HIGH RESOLUTION                      |
| 64. REFERENCES                                      |   |
| <u></u>   | IMPROVED TOS (ITOS) SYSTEM. V.1-3.              |
|   | NO. NASS-9034, JUN 7,68.***2) FINAL             |
|   | ,2,3. RCA ASTRO-ELECTRONICS DIV.                |
|   | 1967.***3) ESSA PRESS RELEASE FOR               |
| ESSA 3, ES 66054, SEPT. 19, 190                     |   |
| APP. 1966, NASA SP-156, 1967.                       | ``  |
| 65. HISTORICAL REMARKS                              |   |
| SIMILAR TO AVCS ON NIMBUS 1 &                       | 2, FSSA 3 & 5 AND ITOS-1                        |
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|                      |                 |        | GILLLIADEL , IIII | J. <b>L</b> U/// |                   |        |                    |          |     |                 |
|----------------------|-----------------|--------|-------------------|------------------|-------------------|--------|--------------------|----------|-----|-----------------|
| 1. TITLE             |                 |        |                   |                  |                   |        | 2. AC              | RONYM    | 3.  | EXP NO          |
| AUTOMATI             | C PICTURE-T     | RANSM  | ISSION SYS        | TEM              |                   |        | AP                 | Ť        |     |                 |
| (TITLE CONT          | .)              |        | <del></del>       |                  |                   |        | 4. RES             | UME DATE |     | 5.<br>VERSION   |
|                      |                 |        |                   |                  |                   |        | 09                 | 7017     | 72  | 0005            |
| 6. PRINCIPAL         | NVESTIGATOR     | 7. OR  | GANIZATION        |                  |                   | 8. TE  | LEPHON             | E        |     |                 |
| MOODY, J             | . C .           | 600    | DARD SPACE        | FLT C            | ENTER             | 30     | 1-982              | /5042    | 2   |                 |
| 9. CO-INVESTI        | GATOR           | 10. OR | GANIZATION        |                  |                   | 11. T  | ELEPHO             | NE.      |     |                 |
|                      |                 |        |                   |                  |                   |        |                    |          |     |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NU | MBER   | 14. FLASH INDEX   | NUMBER           | 15. START<br>DATE | 16. CC | OMPLETION 1        |          |     |                 |
|                      |                 |        |                   |                  |                   |        |                    | POST     | FL  | IGHT            |
| 18. MONITOR          |                 | 19. AG |                   | 20. PGM          | OFFICE            | 21. T  | ELEPHO             | NE       |     |                 |
| GLOVER,              | J.C             | NES    | CINDAA            |                  |                   | 202    | 2-655              | -400     | )   | _               |
| 22. VENDOR           |                 |        | 23. LOCATION      |                  |                   |        | 24. FLIGHT<br>DATE | 25. L    | EAD | TIME            |
| RCA ASTR             | RO-ELECTRONI    | CS     | PRINCETON         | , NEW .          | JER SE            | Υ      | 02/6               | 6 NA     |     |                 |
| 26. INSTRUME         |                 |        |                   |                  |                   |        |                    |          |     | 27.<br>SECURITY |
| IMAGER,              | 1-INCH AUTO     | MAT IC | -PICTURE-T        | RANSMI           | SSION             | VI     | DICON              |          |     | UNC             |
| 28. APPLICATION      | DN              |        |                   | 2                | 9. SPACE          | CRAF   | τ                  |          |     |                 |
| MET                  |                 |        |                   |                  | ESSA              | 2 .    |                    |          |     |                 |
| 30. PURPOSE          |                 |        |                   |                  |                   |        |                    |          |     |                 |

PRIMARY-TO PROVIDE METEOROLOGISTS WITH REALTIME INFORMATION ON CLOUD AND WEATHER CONDITIONS OVER A LARGE AREA AROUND THE RECEIVING STATION\*\*\*SECONDARY-MAINTAIN CAPABILITY OF THE TOS-ESSA SATELLITE SYSTEM.

## 31. PRINCIPLES OF OPERATION

THIS SYSTEM, CONSISTING OF 2-IDENTICAL 1-INCH VIDICON APT CAM-ERAS, WAS ALSO TEST FLOWN ON TIRGS 8 AND NIMBUS 1 AND 2 AND OPERATIONALLY FLOWN ON ESSA 4 AND 6. EACH CAMERA UTILIZES A TE-GEA-KINOPTIC, 108-DEGREE, WIDE ANGLE, F/1.8 OBJECTIVE LENS WITH A FOCAL LENGTH OF 5.7 MM. THE TWO CAMERAS ARE MOUNTED 180 DE-GREES APART ON THE SIDE OF THE SPACECRAFT AND PERPENDICULAR TO THE SPIN AXIS, SO THEY POINT DIRECTLY DOWNWARD ONCE EVERY 5.5 SECS, DURING WHICH TIME PICTURES ARE TAKEN. THE SYSTEM IS PRO-GRAMMED TO TAKE AND TRANSMIT A PICTURE EVERY 350 SECS. FOR A TO-TAL SEQUENCE OF 8 PICTURES, WHILE THE SATELLITE IS IN DAYLIGHT. THE ACTUAL PICTURE TAKING REQUIRES 8 SECS AND THE TRANSMISSION 200 SECS. DURING THIS LATTER PERIOD THE VIDICON IS SCANNED AT FOUR LINES PER SECOND, AND THE SIGNALS TRANSMITTED PRODUCING AN CAMERA HAS A SHUTTER SPEED OF 1.5 MILLSEC AND A VIDEO-BANDWIDTH TRACK. THE SHUTTER UTILIZED IS A MODIFIED TIROS TYPE-F, FULL-SCAN, FOCAL-PLANE SHUTTER ADJUSTED FOR A 1.5-MSEC EXPOSURE. TWO 5-WATT TV TRANSMITTERS ARE USED, EACH PROVIDING A 137.5 MHZ CAR-RIER. AN APT GROUND STATION WITH AN APPROPRIATE ANTENNA, RE-CEIVER, AND A RECORDER CAN RECEIVE THESE PICTURES WHEN THE SPACECRAFT IS WITHIN ACQUISITION RANGE.

## 32. PHENOMENA OBSERVED

CLOUD AND TERRAIN FEATURES OF APPROX 2 NM OR LARGER

## 33. MEASUREMENT RANGE

DYNAMIC PICTURE RANGE OF 25:1

#### 34. PRECISION AND ACCURACY

S/N OF 30 DB AT G.7 FOOT CANDLES/SEC; 10 LEVELS OF GRAY

| 35. SPECTRAL RANGE  | 36. SPECTRAL RESOLUTIO                    | N 37. TIME CONSTANT |
|---|---|---------------------|
| 0.45 TO 0.65  | MICRON NA                                 |                     |
| 38. FIELD OF VIEW   | 39. GROUND SWATH                          |                     |
| 89.0 BY 89.0 DEG  40. ANGULAR RESOLUTION 41. SPATIAL RESO | 1800 NM BY 1800 NM FROM T                 | 750 NM ALTITUDE     |
| 9.132 DEG 1.7 NM FRO                                      |   |                     |
| 42. POINTING ACCURACY 43. POINTING RATE                   |   | INATION             |
|   |   | SYNCH RETROGRADE    |
| 46. SPECIAL REQUIREMENTS                                  | THED CIRCULAR I SON-                      | THE RETROGRADE      |
|   |   |                     |
| 47. COMPONENTS  |   |                     |
|   | ECTRONICS MODULES. 2 FM 1                 |                     |
| 48. WEIGHT 49. VOLUME                                     | 50. AVERAGE POWER 51. STANDBY POWER 52. P | EAK POWER 53. MTBF  |
| 22 LB   | 28 WATTS 4                                | O WATTSI            |
| <u> </u>  | CLEAR 57. INTERPERENCE 58. SHIELDING      |                     |
| SENSITIVE SENSITIVE                                       |   | SHIFLDING USED      |
| SS. CALIBRATION   |   |                     |
| 62. TELEMETRY REQUIREMENTS                                | IREALTIME TELEMETRY   CC                  | NTINUOUS DAYTIME    |
|   | ON, AND PHASING CODE DRIV                 | E A MODULATOR       |
|   | ES THE 2400 HZ SUBCARRIER                 |                     |
| 4000 HZ MAXIMUM FREQUEN                                   |   | INOS REQUIRING      |
| 63. ADVANTAGES AND LIMITATIONS                            |   |                     |
| DIRECT TRANSMISSION TO                                    | MANY GROUND STATIONS WITH                 | DUT INTERMEDIATE    |
| STORAGE ON MAGNETIC TAR                                   |   |                     |
| 64. REFERENCES  |   |                     |
|   | , NAT WEATHER SAT CTR, 19                 |                     |
|   | THE APT TV CAMERA SYSTEM                  |                     |
|   | V. 1963.***3) FINAL ENGIN                 |                     |
|   | 1967. ***4) SIG ACHIEV IN                 |                     |
|   | C , NIBTRALEM DAA                         |                     |
| 65. HISTORICAL REMARKS                                    | SYSTEMS DEVELOPMENT FOR M                 | ET. GSEC. 1968.     |
|   | 8. NIMBUS 1 AND 2. AND F                  | CCA A AND A         |
| STAR III AII III III                                      | OF MIROUS I MNO 25 ARO E                  | 33A 4 ANU 0.        |
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|                      |                   |        | GILLIADELI, MD. 2  | .0,,,       |                   |       |                    |            |     |                 |
|----------------------|-------------------|--------|--------------------|-------------|-------------------|-------|--------------------|------------|-----|-----------------|
| 1. TITLE             |                   |        |                    |             |                   |       | 2. /               | ACRONYM    | 3.  | EXP NO          |
| AUTOMATIC            | PICTURE-TRA       | INSM:  | ISSION SYSTEM      | 1           |                   |       | AP                 | T          |     |                 |
| (TITLE CONT.         |                   |        |                    |             |                   |       | 4. R               | ESUME DATE |     | 5.<br>VERSION   |
|                      |                   |        |                    |             |                   |       | 0.9                | 7/01/7     | 72  | 0005            |
| 6. PRINCIPAL IN      | IVESTIGATOR       | 7. OR  | GANIZATION         |             |                   | 8. TI | ELEPHO             | NE         |     |                 |
| SCHWALB.             | Α.                | NES(   | Z/NOA A            |             |                   | 202   | 2-655              | -4000      | ) _ |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION         |             |                   | 11. T | ELEPHO             | NE         |     |                 |
|                      |                   |        |                    |             |                   |       |                    |            |     |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | MBER        | 15. START<br>DATE | 16. C | OMPLETION<br>DATE  | 17. STAT   | US  |                 |
|                      |                   |        |                    |             |                   |       |                    | POST       | FL  | IGHT            |
| 8. MONITOR           |                   | 19. AG | ENCY               | 20. PG      | M OFFICE          | 21. 1 | ELEPHO             | ONE        |     |                 |
| GLOVER               | J.C.              | NES    | CANDAA             |             |                   | 202   | 2-655              | -4000      |     |                 |
| 22. VENDOR           |                   |        | 23. LOCATION       |             |                   |       | 24. FLIGHT<br>DATE | 25. L      | EAC | TIME            |
| RCA ASTRO            | D-ELECTRONICS     | 3      | PRINCETON, N       | ۱. J.       |                   |       | 01/6               | 7 NA       |     |                 |
| 26. INSTRUMEN        | T TYPE            |        | 4                  |             |                   |       |                    |            |     | 27.<br>SECURITY |
| IMAGER,              | 1-INCH AUTOMA     | TIC-   | -PICTURE-TRAN      | <b>VSMI</b> | SSION             | VI    | DICON              | J          |     | UNC             |
| 28. APPLICATIO       |                   |        |                    |             | 29. SPACE         |       |                    |            |     |                 |
| MET                  |                   |        |                    |             | ESSA 4            | 4     |                    |            |     |                 |
| 30. PURPOSE          |                   |        | ,                  |             |                   |       |                    |            |     |                 |

PRIMARY-TO PROVIDE METEOROLOGISTS WITH REALTIME INFORMATION ON CLOUD AND WEATHER CONDITIONS OVER A LARGE AREA AROUND THE RECEIVING STATION.\*\*\*SECONDARY-MAINTAIN CAPABILITY OF THE TOSESSA SATELLITE SYSTEM.

## 31. PRINCIPLES OF OPERATION

THIS SYSTEM, CONSISTING OF TWO IDENTICAL 1-INCH VIDICON APT CAM-ERAS, WAS ALSO TEST FLOWN ON TIROS 8 AND NIMBUS 1 AND 2 AND OPERATIONALLY FLOWN ON ESSA 2 AND 6. EACH CAMERA UTILIZES A TE-GEA-KINOPTIC, 108-DEGREE, WIDE-ANGLE, F/1.8 OBJECTIVE LENS WITH A FOCAL LENGTH OF 5.7MM. THE TWO CAMERAS ARE MOUNTED 180 DEGREES APART ON THE SIDE OF THE SPACECRAFT AND PERPENDICULAR TO THE SPIN AXIS, SO THEY POINT DIRECTLY DOWNWARD ONCE EVERY 5.5 SECS, DURING WHICH TIME PICTURES ARE TAKEN. THE SYSTEM IS PROGRAMMED TO TAKE AND TRANSMIT A PICTURE EVERY 350 SECS FOR A TOTAL OF 8 PICTURES, WHILE THE SATELLITE IS IN DAYLIGHT. THE ACTUAL PIC-TURE TAKING REQUIRES 8 SECS AND THE TRANSMISSION 200 SECS. DUR-ING THIS LATTER PERIOD THE VIDICON IS SCANNED AT FOUR LINES PER SECOND, AND THE SIGNALS TRANSMITTED PRODUCING AN 800-LINE PIC-TURE WITH SCAN LINES PERPENDICULAR TO THE ORBIT TRACK. THE SHUT-TER UTILIZED IS A MODIFIED TIROS TYPE-F, FULL-SCAN, FOCAL-PLANE SHUTTER ADJUSTED FOR A 1.5-MSEC EXPOSURE. TWO 5-WATT TV TRANS-MITTERS ARE USED, EACH PROVIDING A 137.5-MHZ CARRIER. AN APT GROUND STATION WITH AN APPROPRIATE ANTENNA, RECEIVER, AND A RE-CORDER CAN RECEIVE THESE PICTURES WHEN THE SPACECRAFT IS WITHIN ACQUISITION RANGE.

#### 32. PHENOMENA OBSERVED

CLOUD AND TERRAIN FEATURES OF APPROX 2 NM OR LARGER

33. MEASUREMENT RANGE

DYNAMIC PICTURE RANGE 25:1

34. PRECISION AND ACCURACY

S/N OF 30 DB AT 0.7 FOOT-CANDLES/SEC: 10 LEVELS OF GRAY

| 35. SPECTRAL RANGE   |                  | 36. SPECTRAL RESOL          | JTION 37. TIME CONSTANT      |
|--|------------------|-----------------------------|------------------------------|
| 0.45 TO 0.65   | MICRON           | NA                          |                              |
| 38. FIELD OF VIEW  | 39. GROUND SWA   | TH                          |                              |
| 89.0 BY 89.0 DEG   | 1800 NM BY       | 1800 NM FRC                 | M 750 NM ALTITUDE            |
| 40. ANGULAR RESOLUTION 41, SPATIAL RES   |                  |                             |                              |
| 0.132 DEG 1.7 NM FR  | OM 750 NM A      | LTITUDE                     |                              |
| 42. POINTING ACCURACY 43. POINTING RAT   |                  |                             | INCLINATION                  |
|  | MED              | CIRCULAR SU                 | N-SYNCH RETROGRADE           |
| 46. SPECIAL REQUIREMENTS   |                  |                             |                              |
|  |                  |                             |                              |
| 47. COMPONENTS   |                  | ·····                       |                              |
| 2 VIDICON CAMERAS, 2 E   |                  |                             |                              |
| 48. WEIGHT 49. VOLUME  | 50. AVERAGE POWE | a lare a constant mental of |                              |
| 55 LB  | 28 WAT1          |                             | 40 WATTS                     |
| The second secon | UCLEAR 57. THE   | FERRAL 58. SHIE             |                              |
| SENSITIVE SENSITIVE  |                  |                             | TIC SHIELDING USED           |
| 59. CALIBRATION  | 60. DATA REC     |                             | 61. FREQUENCY OF OBSERVATION |
|  | REALTIME         | TELEMETRY                   | CONTINUOUS DAYTIME           |
| 62. TELEMETRY REQUIREMENTS   |                  |                             |                              |
| THE VIDEO OUTPUT, TURN   | •                |                             |                              |
| WHICH AMPLITUDE MODULA   |                  |                             | IER, THUS REQUIRING          |
| 4000 HZ MAXIMUM FREQUE   | ICY CAPABIL      | ITY.                        |                              |
| 63. ADVANTAGES AND LIMITATIONS   | 1441111 000011   | 0.07477                     |                              |
| DIRECT TRANSMISSION TO   |                  | ID STATIONS W               | ITHOUT INTERMEDIATE          |
| STORAGE ON MAGNETIC TA   | 'E•              |                             |                              |
| 64. REFERENCES   |                  | 1125 647 67-                | 10/5                         |
| 1) APT USERS GUIDE. ESS  | -                |                             | •                            |
| R.A. AND STROUD, W.G.:   |                  |                             |                              |
| NASA/GSFC TN D-1915, NO  |                  |                             |                              |
| TOS/OT-2. PCA CORP. MAY  |                  |                             |                              |
| NASA SP-156.***5) OSTRO  |                  |                             |                              |
| DECADE OF SPACE CAMERA 65. HISTORICAL REMARKS  | SAZIEMZ DE       | VELUPMENT FJ                | R MET. GSFC. 1968.           |
|  | · O NEMOUS       | 1 440 2 44                  | D 5554 2 4ND /               |
| SIMILAR TO APT ON TIROS  | S 8 NIMBUS       | I AND Z, AN                 | U ESSA Z ANU 6.              |
|  |                  |                             |                              |
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GREENBELT MD 20771

|                      |                   |        | GITELITELET, MD. 2 | .0,,,  |                   | _                |                    |          |       | _               |
|----------------------|-------------------|--------|--------------------|--------|-------------------|------------------|--------------------|----------|-------|-----------------|
| 1. TITLE             |                   |        |                    |        |                   |                  | 2. /               | ACRONY   | м 3.  | EXP NO          |
| ITAMOTUA             | C PICTURE-TRA     | ANSM   | ISSION SYSTE       | М      |                   |                  | ΔF                 | 7        |       |                 |
| (TITLE CONT.         | )                 |        |                    |        |                   | .,,,,,,,,,,,     | 4. R               | ESUME DA | ATE   | 5.<br>VERSION   |
|                      |                   |        |                    |        |                   |                  | CS                 | 7/01     | 172   | 0005            |
| 6. PRINCIPAL II      | NVESTIGATOR       | 7. OR  | GANIZATION         |        |                   | 8. TI            | ELEPHO             | NE       |       |                 |
| SCHWALB,             | Α.                | NES    | CINDAA             |        |                   | 20               | 2-659              | 5-40     | 00    |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION         |        |                   | 11. T            | ELEPHO             | NE       |       |                 |
|                      |                   |        |                    |        |                   |                  |                    |          |       |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | MBER   | 15. START<br>DATE | 16. <sup>C</sup> | OMPLETION<br>DATE  | 17. ST   | ATUS  | ,               |
|                      |                   |        |                    |        |                   |                  |                    | POS      | T-F   | LIGHT           |
| 18. MONITOR          |                   | 19. AG | ENCY               | 20. PG | M OFFICE          | 21. 1            | ELEPHO             | ONE      |       |                 |
| GLOVER,              | J.C.              | NES    | C/NDAA             |        |                   | 20.              | 2-655              | 5-40     | 00    |                 |
| 22. VENDOR           |                   | •      | 23. LOCATION       |        |                   |                  | 24. FLIGHT<br>DATE | 25       | . LEA | D TIME          |
| RCA ASTR             | O-ELECTRONIC      | S      | PRINCETON,         | N.J.   | )                 |                  | 11/6               | 57 N     | Δ     |                 |
| 26. INSTRUMEN        |                   |        |                    |        |                   |                  |                    |          |       | 27.<br>SECURITY |
| IMAGER,              | 1-INCH AUTOM      | ATIC.  | -PICTURE-TRAI      | NSMI   | SSION             | ٧I               | DICON              | ٧        |       | UNC             |
| 28. APPLICATIO       | N .               |        |                    |        | 29. SPACE         | CRAF             | T                  |          |       |                 |
| MET                  |                   |        |                    |        | ESSA              | 5                |                    |          |       |                 |
| 30. PURPOSE          |                   |        |                    |        |                   |                  |                    |          |       |                 |
|                      |                   |        |                    |        |                   |                  |                    |          |       |                 |

PRIMARY-TO PROVIDE METEOROLOGISTS WITH REALTIME INFORMATION ON CLOUD AND WEATHER CONDITIONS OVER A LARGE AREA AROUND THE RECEIVING STATION.\*\*\*SECONDARY-MAINTAIN CAPABILITY OF THE TOS-ESSA SATELLITE SYSTEM.

## 31. PRINCIPLES OF OPERATION

THIS SYSTEM, CONSISTING OF TWO IDENTICAL 1-INCH VIDICON APT CAM-ERAS, WAS ALSO TEST FLOWN ON TIROS 8 AND NIMBUS 1 AND 2 AND OP-ERATIONALLY FLOWN ON ESSA 2 AND 4. EACH CAMERA UTILIZES A TEGEA-KINDPTIC, 108-DEGREE, WIDE-ANGLE, F/1.8 OBJECTIVE LENS WITH A FOCAL LENGTH OF 5.7 MM. THE TWO CAMERAS ARE MOUNTED 180 DEGREES APART ON THE SIDE OF THE SPACECRAFT AND PERPENDICULAR TO THE SPIN AXIS. SO THEY POINT DIRECTLY DOWNWARD ONCE EVERY 5.5 SECS DURING WHICH TIME PICTURES ARE TAKEN. THE SYSTEM IS PROGRAMMED TO TAKE AND TRANSMIT A PICTURE EVERY 350 SECS FOR A TOTAL OF 8 PICTURES, WHILE THE SATELLITE IS IN DAYLIGHT. THE ACTUAL PICTURE TAKING REQUIRES 8 SECS AND THE TRANSMISSION 200 SECS. DURING THIS LATTER PERIOD THE VIDICON IS SCANNED AT FOUR LINES PER SEC-OND, AND THE SIGNALS TRANSMITTED PRODUCING AN 800-LINE PICTURE WITH SCAN LINES PERPENDICULAR TO THE ORBIT TRACK. THE SHUTTER UTILIZED IS A MODIFIED TIROS TYPE-F, FULL SCAN, FOCAL-PLANE SHUTTER ADJUSTED FOR A 1.5-MSEC EXPOSURE. TWO 5-WATT TV TRANS-MITTERS ARE USED, EACH PROVIDING A 137.5-MHZ CARRIER. AN APT GROUND STATION WITH AN APPROPRIATE ANTENNA. RECEIVER. AND A RE-CORDER CAN RECEIVE THESE PICTURES WHEN THE SPACECRAFT IS WITHIN ACQUISITION RANGE.

#### 32. PHENOMENA OBSERVED

CLOUD AND TERRAIN FEATURES OF APPROXIMATELY 2 NM OR LARGER

## 33. MEASUREMENT RANGE

DYNAMIC PICTURE RANGE OF 25:1

## 34. PRECISION AND ACCURACY

S/N OF 30 DB AT 0.7 FOOT CANDLES/SEC; 10 LEVELS OF GRAY

| 35. SPECTRAL RANGE                       | 1                     | CTRAL RESOLUTIO    | N 37. TIME CONSTANT      |
|--|-----------------------|--------------------|--------------------------|
| 0.45 TO 0.65                             | MICRON NA             |                    |                          |
|  | 9. GROUND SWATH       |                    |                          |
| 89.0 BY 89.0 DEG                         | 1800 NM BY 18         | OO NM FROM         | 750 NM ALTITUDE          |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESOL |                       |                    |                          |
| 0.132 DEG 1.7 NM FRO                     | 750 NM ALTI           | TUDE               |                          |
| 42. POINTING ACCURACY 43. POINTING RATE  | 44. ALTITUDE          | 45. INCL           | INATION                  |
|  | MED CIR               | CULAR SUN-         | SYNCH RETROGRADE         |
| 46. SPECIAL REQUIREMENTS                 |                       |                    |                          |
|  |                       |                    |                          |
| 47. COMPONENTS                           | •                     |                    |                          |
| 2 VIDICON CAMERAS, 2 EL                  | CTRONICS MOD          | ULES, 2 FM         | TRANSMITTERS             |
| 48. WEIGHT 49. VOLUME                    | 50. AVERAGE POWER 51. | STANDBY POWER 52.1 | PEAK POWER 53. MTBF      |
| 55 LB                                    | 28 WATTS              |                    | 40 WATTS                 |
| 54. INTERFERENCE 55. MAGNETIC 56. NUC    | EAR 57 THERMAL        | 58. SHIELDIN       | G                        |
| SENSITIVE SENSITIVE                      |                       | MAGNETI            | C SHIELDING USED         |
| 59. CALIBRATION                          | 60. DATA RECOVERY     | 61.                | FREQUENCY OF OBSERVATION |
|  | REALTIME TE           | LEMETRY C          | ONTINUOUS DAYTIME        |
| 62. TELEMETRY REQUIREMENTS               |                       |                    |                          |
| THE VIDEO OUTPUT, TURN-0                 | ON, AND PHASI         | NG CODE DRI        | VE A MODULATOR           |
| WHICH AMPLITUDE MODULAT                  | S THE 2400 H          | Z SUBCARRIE        | R, THUS REQUIRING        |
| 4000 HZ MAXIMUM FREQUEN                  | Y CAPABILITY          | •                  |                          |
| 63. ADVANTAGES AND LIMITATIONS           |                       |                    |                          |
| DIRECT TRANSMISSION TO                   | MANY GROUND S         | TATIONS WITH       | HOUT INTERMEDIATE        |
| STORAGE ON MAGNETIC TAP                  |                       |                    |                          |
| 64. REFERENCES                           |                       |                    | ,                        |
| 1) APT USERS GUIDE ESSA                  | NAT WEATHER           | SAT CTR. 1         | 965.***2)STAMPFL.        |
| R.A. AND STROUD, W.G.:                   |                       | •                  | • 1                      |
| NASA/GSFC TN D-1915, NO                  |                       |                    |                          |
| TOS/OT-2. RCA CORP. MAY                  |                       |                    | •                        |
| NASA SP-156.***5) DSTRO                  |                       |                    |                          |
| DECADE OF SPACE CAMERA                   | -                     | · ·                |                          |
| 65. HISTORICAL REMARKS                   |                       |                    |                          |
| SIMILAR TO APT ON TIROS                  | 8. NIMBUS 1           | AND 2. AND         | FSSA 2 AND 4.            |
|  |                       |                    |                          |
|  |                       |                    |                          |
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GREENBELT, MD. 20771

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|----------------------|-------------------|--------|--------------------|--------|-------------------|-------|--------------------|----------|-------|----------|-----------------|
| 1. TITLE             |                   |        |                    |        |                   |       | 2. /               | ACRONY   | м 3   | . EX     | P NO            |
| AUTOMATIO            | C PICTURE-TE.     | ANSM   | ISSION SYSTE       | Ą      |                   |       | ΔΕ                 | 7 7      |       |          |                 |
| (TITLE CONT.         | )                 |        |                    |        |                   |       | 4. R               | ESUME DA | TE    | 5.<br>Vi | RSION           |
|                      |                   |        |                    |        |                   |       | Ü                  | 370I     | 772   | 2 0      | 005             |
| 6. PRINCIPAL IN      | IVESTIGATOR       | 7. OR  | GANIZATION         |        |                   | 8. TI | ELEPHO             | NE       |       |          |                 |
| SWCWALB.             | Α.                | NES    | C/NOAA             |        |                   | 20    | 2-65               | 5-40     | 0.0   |          |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION         |        |                   | 11. T | ELEPHO             | NE       |       |          |                 |
|                      |                   |        |                    |        |                   |       |                    |          |       |          |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | MBER   | 15. START<br>DATE | 16. C | OMPLETION<br>DATE  |          |       | _        |                 |
|                      |                   |        |                    |        |                   |       |                    | POS      | TF    | LI       | GHT             |
| 18. MONITOR          |                   | 19. AG | ENCY               | 20. PG | M OFFICE          | 21. T | ELEPHO             | ONE      |       |          |                 |
| GLOVER,              | J. C.             | NES    | CINDAA             |        |                   | 20    | 2 <del>-</del> 659 | 5-40     | 00    |          |                 |
| 22. VENDOR           |                   |        | 23. LOCATION       |        |                   |       | 24. FLIGHT<br>DATE | 25       | . LEA | AD T     | IME             |
| RCA ASTR             | D-ELECTONICO      | S      | PRINCETON.         | N.J.   | )                 |       | 12/6               | 58       |       |          |                 |
| 26. INSTRUMEN        |                   |        |                    |        |                   |       |                    |          |       |          | 27.<br>SECURITY |
| IMAGER,              | 1-INCH AUTOM      | AT IC  | -PICTURE-TRA       | NSMI   | ISSION            | ۷IJ   | DICO               | V        |       |          |                 |
| 28. APPLICATIO       | N                 |        |                    |        | 29. SPACE         | CRAF  | T                  |          |       |          |                 |
| MET                  |                   |        |                    |        | ESSA-             | 8     |                    |          |       |          |                 |
| 30. PURPOSE          |                   |        |                    |        |                   |       |                    |          |       |          |                 |

PRIMARY- TO PROVIDE REALTIME CLOUD COVER PICTURES OVER A LARGE AREA AROUND ANY SUITABLY EQUIPPED RECEIVING STATION. \*\*\* SECONDARY- TO MAINTAIN CAPABILITY OF THE TOS-ESSA SATELLITE SYSTEM.

#### 31. PRINCIPLES OF OPERATION

THIS SYSTEM SCHEDULED FOR FLIGHT ON TOS H, CONSISTING OF TWO IDENTICAL 1-INCH VIDICON APT CAMERAS, WAS ALSO TEST FLOWN ON TIROS 8 AND NIMBUS 1 AND 2, AND OPERATIONALLY FLOWN ON ESSA 2,4, 6 AND 8. EACH CAMERA UTILIZES A TEGEA-KINDPTIC, 108-DEG WIDE-ANGLE, F/1.8 OBJECTIVE LENS WITH A FOCAL LENGTH OF 5.7 MM. THE 2 CAMERAS ARE MOUNTED 180 DEG APART ON THE SIDE OF THE SPACECRAFT AND PERPENDICULAR TO THE SPIN AXIS, SO THEY POINT DIRECTLY DOWNWARD ONCE EVERY 5.5 SECS, DURING WHICH TIME PIC-TURES ARE TAKEN. THE SYSTEM IS PROGRAMMED TO TAKE AND TRANSMIT A PICTURE EVERY 350 SECS FOR A TOTAL OF 8 PICTURES, WHILE THE SATELLITE IS IN DAYLIGHT. THE ACTUAL PICTURE TAKING REQUIRES 8 SECS AND THE TRANSMISSION 200 SECS. DURING THIS LATTER PERIOD THE VIDICON IS SCANNED AT FOUR LINES PER SECOND. AND THE SIGNALS TRANSMITTED PRODUCING AN 800-LINE PICTURE WITH SCAN LINES PER-PENDICULAR TO THE ORBIT TRACK. THE SHUTTER UTILIZED IS A MODIFIED TIROS TYPE-F, FULL-SCAN, FOCAL-PLANE SHUTTER, ADJUSTED FOR A 1.5 MILSEC EXPOSURE. TWO 5-WATT TV TRANSMITTERS ARE USED, EACH PROVIDING A 137.5-MHZ CARRIER. AN APT GROUND STATION WITH AN APPROPRIATE ANTENNA, RECEIVER, AND A RECORDER CAN RECEIVE THESE PICTURES WHEN THE SPACECRAFT IS WITHIN ACQUISTION RANGE.

## 32. PHENOMENA OBSERVED

CLOUD AND TERRAIN FEATURES OF APPROX 2 NM OR LARGER

## 23. MEASUREMENT RANGE

DYNAMIC PICTURE RANGE 25:1

## M. PRECISION AND ACCURACY

S/N OF 30 DB AT 0.7 FOOT-CANDLES/SEC; 10 LEVELS OF GRAY

| Con correction and a second                        |              | Too       |  |                                       |
|--|--------------|-----------|--|---------------------------------------|
| 35. SPECTRAL RANGE                                 | MICCOL       |           | L RESOLUTION   | 37. TIME CONSTANT                     |
| 0.45 TO 0.65                                       |              | I NA      |  |                                       |
| L  | . GROUND SW  |           |  |                                       |
| 89.0 BY 89.0 DEG I                                 | BOO NM F     | 8Y 1800 N | M FROM 75  | O NM ALTITUDE                         |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESOLU          |              |           |  |                                       |
| 0.132 DEG 1.7 NM FROM                              | 740 NM       | ALTITUDE  |  |                                       |
| 42. POINTING ACCURACY 43. POINTING RATE            | 44. ALT      | TTUDE     | 45. INCLINA  | ATION                                 |
|  | MED          | CIRCULA   | R SUN SY   | NCH RETORGRADE                        |
| 46. SPECIAL REQUIREMENTS                           |              |           |  | · · · · · · · · · · · · · · · · · · · |
| 2  |              |           |  |                                       |
| 47. COMPONENTS                                     |              |           | <del></del>  |                                       |
| 2 VIDICON CAMERAS, 2 ELE                           | CTRONTCS     | MODULES   | . 2 FM TR  | ANSMITTERS                            |
|  |              |           | Y POWER 52. PEA  |                                       |
| 55 LB  | 28 WAT       |           | the second second for the second seco | WATTS                                 |
| S4- INTERFERENCE S8. INTERFERENCE S8. INTERFERENCE |              |           | 58. SHIELDING  |                                       |
| SENSITIVE  | IENCE ST. IN |           |  | SHIELDING USED                        |
| 59. CALIBRATION                                    | ISO 50 TA == |           |  | QUENCY OF OBSERVATION                 |
| VALIDRA IIUR                                       | 60. DATA RE  |           | 4694   |                                       |
|  | LECALTIM     | IE TELEME | IFT   CON  | TINUOUS DAYTIME                       |
| 62. TELEMETRY REQUIREMENTS                         | N1 4         |           | 005 555  | 4 440.044 4 5 5 5                     |
| THE VIDEO OUTPUT, TURN-O                           | •            |           |  |                                       |
| WHICH AMPLITUDE MODULATE                           |              |           |  | THUS RE-                              |
| QUIRING 4000 HZ MAXIMUM                            | FREQUENC     | Y CAPABI  | LITY.  |                                       |
| 63. ADVANTAGES AND LIMITATIONS                     | 0 / E        |           |  |                                       |
| DIRECT TRANSMISSION TO M                           |              |           |  |                                       |
| STORAGE ON MAGNETIC TAPE                           | . 2 CAME     | RAS INSU  | RE LONG O  | PERATING PERIOD                       |
| 64. REFERENCES                                     |              |           | <u> </u>   |                                       |
| 1) APT USERS GUIDE. ESSA,                          | NAT WEA      | THER SAT  | CTR, 196   | 5.***21STAMPFL.                       |
| R.A. AND STROUD, W.G.: T                           |              |           | •  | · ·                                   |
| NASA/GSFC TN D-1915, NOV                           |              |           |  | · · · -                               |
| TOS/OT-2. RCA CORP. MAY                            |              |           |  |                                       |
| NASA SP-156.***510STROW.                           |              |           |  |                                       |
| DECADE OF SPACE CAMERA S                           |              |           |  |                                       |
| 65. HISTORICAL REMARKS                             |              |           | J. J. HL   | 7,00                                  |
| FLOWN ON TIROS 8, NIMBUS                           | 1.2. AND     | FSSA 2-   | 4.6:41 50  | SCHED END THE H                       |
| TOWN ON TINOS OFFICEOUS                            | TACA WIAN    |           | TOTALSU  | SOURS LOW 103 U                       |
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## NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER

GREENBELT, MD. 20771

|   |                   |        | <del></del>        |            |                   |                  |                   |            |      |                 |
|---|-------------------|--------|--------------------|------------|-------------------|------------------|-------------------|------------|------|-----------------|
| 1. TITLE                                  |                   |        |                    |            |                   |                  | 2. /              | ACRONYM    | 3. 6 | EXP NO          |
| AUTOMATIO                                 | PICTURE-TRA       | NSMI   | ISSION SYSTEM      | 1          |                   |                  | ΔP                | T          |      |                 |
| (TITLE CONT.                              |                   |        |                    |            |                   |                  | 4. R              | ESUME DATE |      | 5.<br>VERSION   |
|   |                   |        |                    |            |                   |                  | 0.9               | /01/7      | 72   | <u> </u>        |
| 6. PRINCIPAL INVESTIGATOR 7. ORGANIZATION |                   |        |                    |            |                   | 8. TELEPHONE     |                   |            |      |                 |
| OBRIEN,                                   | J. (T.MON)        | GODO   | DARD SPACE FL      | TC         | ENTER             | 301              | 1-982             | -5042      | 2    |                 |
| 9. CO-INVESTIG                            |                   | 10. OR | GANIZATION         |            |                   | 11. T            | ELEPHO            | NE         |      |                 |
|   |                   |        |                    |            |                   |                  |                   |            |      |                 |
| 12. CONTRACT<br>TYPE                      | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | MBER       | 15. START<br>DATE | 16. <sup>C</sup> | OMPLETION<br>DATE | 17. STA    | rus  |                 |
| CPFF                                      |                   |        |                    |            |                   |                  |                   | INTE       | GRA  | TION            |
| 18. MONITOR                               |                   | 19. AG | ENCY               | 20. PG     | M OFFICE          | 21. 1            | TELEPH(           | ONE        |      |                 |
| GARBACZ,                                  | M.L.              | NASA   | HDQTRS             | OA/        | 'ERO              | 202              | 2-755             | -2322      | 2    |                 |
| 22. VENDOR                                |                   |        | 23. LOCATION       |            |                   |                  | 24. FLIGH<br>DATE | ¹ 25. L    | .EAD | TIME            |
| RCA ASTRI                                 | -ELECTRONICS      | 5      | PRINCETON, N       | <b>I.J</b> |                   |                  | 1/70              | ) NA       |      |                 |
| 26. INSTRUMEN                             | IT TYPE           |        |                    |            |                   |                  |                   |            |      | 27.<br>SECURITY |
| IMAGER,                                   | 1-INCH AUTOMA     | TIC-   | -PICTURE-TRAN      | V SM I     | SSION             | VII              | DICON             | 1          |      | UNC             |
| 28. APPLICATIO                            |                   |        |                    |            | 29. SPACE         |                  |                   |            |      |                 |
| MET                                       |                   |        |                    |            | ITOS-             | 1                |                   |            |      |                 |
| 30. PURPOSE                               | ·                 |        |                    |            |                   |                  |                   |            |      |                 |
|   |                   |        |                    |            |                   |                  |                   |            |      |                 |

PRIMARY-TO PROVIDE METEOROLOGISTS WITH DAYTIME OBSERVATIONS OF CLOUD COVER AS DETECTED IN THE VISIBLE SPECTRUM FOR DIRECT TRANSMISSION TO USERS LOCATED AROUND THE WORLD.\*\*\*SECONDARY-TO EXPAND THE OPERATIONAL CAPABILITY OF THE BASIC TOS SYSTEM.

#### 31. PRINCIPLES OF OPERATION

THE APT CAMERA SUBSYSTEM HAS ALSO BEEN FLOWN PREVIOUSLY ON TIROS 8. NIMBUS 1.2.AND ESSA 2.4.6 IN SIMILAR CONFIGURATION. THE TIROS M SUBSYSTEM WILL CONSIST OF 2 IDENTICAL 1-INCH VIDICON APT CAM-ERAS, EACH UTILIZING A TEGRA-KINOPTIC, 108-DEG, WIDE-ANGLE, F/1.8 OBJECTIVE LENS WITH A FOCAL LENGTH OF 5.7 MM. ONLY ONE CAMERA IS UTILIZED FOR OPERATION DURING ANY PICTURE-TAKING SEQUENCE. THE APT SUBSYSTEM IS CONTROLLED BY GROUND-INITIATED COMMANDS THAT ARE TRANSMITTED TO AND STORED BY THE SATELLITE.ONCE THE SEQUENCE IS INITIATED, THE CAMERA WILL TAKE A PICTURE ONCE EVERY 260 SEC UNTIL THE PRESCRIBED 11 PICTURES HAVE BEEN TAKEN. THE ACTUAL PICTURE TAKING REQUIRES 8 SEC WITH AN EXPOSURE TIME OF 25 MILLI-SEC. AND THE TRANSMISSION 150.SECS. DURING THIS LATTER PERIOD THE VIDICON IS SCANNED AT 4 LINES PER SEC. AND THE SIGNALS TRANSMITTED PRODUCING AN 600-LINE PICTURE WITH SCAN LINES PER-PENDICULAR TO THE ORBIT TRACK. TWO 5-WATT TV TRANSMITTERS ARE USED, EACH PROVIDING A 137.62 MHZ CARRIER. AN APT GROUND STATION WITH AN APPROPRIATE ANTENNA, RECEIVER, AND A RECORDER CAN RE-CEIVE THESE PICTURES WHEN THE SPACECRAFT IS WITHIN ACQUISITION RANGE.

#### 32. PHENOMENA OBSERVED

CLOUD AND TERRAIN FEATURES OF APPROX 3.4 NM OR LARGER

33. MEASUREMENT RANGE

DYNAMIC PICTURE RANGE OF 20:1

M. PRECISION AND ACCURACY.

S/N OF 32 DB, MINIMUM; 8 GRAY LEVELS CAN BE RESOLVED

A STATE OF THE STA

| 35. SPECTRAL RANGE   |  | 36   | . SPECTRAL RI  | SOLUTION   | 37. TIME CONSTANT  |
|--|--|--|--|--|--|
|  | 65 MI  | CRONS N  | Α  |  | 208. SECONDS   |
| 38. FIELD OF VIEW  |  | OUND SWATH   | Add an amendation and approximately and approximately  |  |  |
|  |  |  | 1700 NM  | FROM 75  | O NM ALTITUDE  |
| 40. ANGULAR RESOLUTION 41. SPATIAL   | RESOLUTION   | <b>4</b>   |  |  |  |
| 0.25 DEG 3.4 NM  | PER TV-  | LINE AT  | CENTER   | FROM 75  | O NM ALTITUDE  |
| 42. POINTING ACCURACY 43, POINTING   |  | 44. ALTITU   | The state of the s | 45. INCLINA  | TION   |
|  | · · · · · · · · · · · · · · · · · · ·  | of C. Miller Co., redictions of the firm   | IRCULAR  | SUN-SY   | NCH RETROGRADE   |
| 46. SPECIAL REQUIREMENTS   |  |  |  |  |  |
| )  |  |  | and the state of t | A CONTRACTOR OF THE PARTY OF TH | and the second s |
| 47. COMPONENTS   | Control of College (1981 and one of colleges and one of the desired of the colleges of the col | and the second s | and Millian and Control of the Contr |  | The second secon |
| CAMERAS (2), ELECTRO   | NICS 12  | 1  |  | <u>isang labah na digaman na mpana</u>   | age of the state o |
| 48. WEIGHT 49. VOLUME  | THE PERSON NAMED IN COLUMN TWO IS NOT THE OWNER, OF THE OWNER, OW | I<br>ERAGE POWER   | 51. STANDBY PO   | wrn 62 06 A  | K POWER 53. MTBF   |
| Party of the state | an agreement a subaggiora de l'inscribination de anno  | alandar and transaction of the second second   | and the contraction of the contr |  | and the second s |
|  |  | 7 WATTS  |  |  | WATTS 1 YEAR   |
|  | 6. NUCLEAR<br>INTERFERENCE   | 57. INTERFE  | *ENCE 58.  | SHIELDING  |  |
| SENSITIVE SENSITIVE  |  |  |  |  |  |
| 59. CALIBRATION  | and the second s | DATA RECOV   | All I discussion and Arisman Inc.  |  | QUENCY OF OBSERVATION  |
|  | <u>  RE</u>  | ALTIME   | TELEMETR   | Y DAY  | TIME ON COMMAND  |
| 62. TELEMETRY REQUIREMENTS   |  |  |  |  |  |
| THE VIDEO OUTPUT, TU   |  |  |  |  |  |
| WHOSE AMPLITUDE MODU   | LATES T  | HE 2400  | HZ SUBC  | ARRIER,  | WHICH IN TURN  |
| MODULATES THE 137.62   | MHZ CA   | RRIER.   |  |  |  |
| 63. ADVANTAGES AND LIMITATION  | 3  |  |  |  |  |
| AN IMPROVED DOUBLE-B   | LADED, S   | OLENDID  | -ACTUATE   | D SHUTT  | ER WILL BE USED  |
| ON THIS APT. REVISED   |  |  |  |  |  |
| 64. REFERENCES   |  |  |  |  |  |
| 11DESIGN STUDY REPOR   | T FOR T  | HE THER  | OVED TOS   | (ITOS)   | SYSTEM.VOL.1.2.  |
| RCA ASTRO-ELECTRONIC   |  |  |  |  |  |
| APT USER'S GUIDE. ES   |  |  |  |  |  |
| R.A. AND STROUD. W.G   |  |  |  |  |  |
| NASA TN D-1915, NOV.   |  |  |  |  | · · · · · · · · · · · · · · · · · · ·  |
| · · · · · · · · · · · · · · · · · · ·  |  |  | NAL CNG!   | NEEKING  | KEPUKI 103/  |
| OT-2. RCA CORP., MAY   | , 1767.  |  | and the second s |  |  |
| O. AISTURICAL REMARKS  |  |  |  |  | A second of the  |
|  |  |  |  |  | · · · · · · · · · · · · · · · · · · ·  |
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GREENBELT MD 20771

|                                   |                   |        | GITEE110CC1, 1110. 2 |         |                   |       |                   |       |       | _    |                 |
|-----------------------------------|-------------------|--------|----------------------|---------|-------------------|-------|-------------------|-------|-------|------|-----------------|
| 1. TITLE                          |                   |        |                      |         |                   |       | 2. /              | ACRO  | NYM   | 3. E | XP NO           |
| AUTOMATIC                         | C PICTURE-TRA     | NSM    | ISSION SYSTEM        | 4       |                   |       | A                 | PT    |       |      |                 |
| (TITLE CONT.                      | )                 |        |                      |         | -                 |       | 4. R              | ESUME | DATE  | 3    | 5.<br>VERSION   |
|                                   |                   |        |                      |         |                   |       | L C C             | 970   | 17    | 72   | 7005            |
| 6. PRINCIPAL IN                   | NVESTIGATOR       |        | GANIZATION           |         |                   |       | ELEPHO            |       |       |      |                 |
| HUNTER, C.M. GUDDARD SPACE FLT CE |                   |        |                      |         | ENTER             | 30    | 1-982             | 2 - 5 | 5242  | ?    |                 |
| 9. CO-INVESTIG                    | ATOR              | 10. OR | GANIZATION           |         |                   | 11. T | ELEPHO            | ONE   |       |      |                 |
|                                   |                   |        |                      |         |                   |       |                   |       |       |      |                 |
| 12. CONTRACT                      | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU   | MBER    | 15. START<br>DATE | 16. C | OMPLETION<br>DATE | 17.   | STAT  | US   |                 |
|                                   |                   |        |                      |         |                   |       |                   | PC    | ST    | FL   | IGHT            |
| 18. MONITOR                       |                   | 19. AG | ENCY                 | 20. PGN | OFFICE            | 21. T | TELEPH(           | ONE   |       |      |                 |
| TEPPER,                           | М.                | NAS    | A HDQTRS             | OA/     | ERD               | 202   | 2-755             | 5-2   | 2322  | 2    |                 |
| 22. VENDOR                        |                   |        | 23. LOCATION         |         | *                 |       | 24. FLIGH<br>DATE | T     | 25. L | EAD  | TIME            |
| RCA ASTRO                         | D-ELECTRONICS     | Ŝ      | PRINCETON, 1         | V.J.    |                   |       | 08/6              | 54    | NΔ    |      |                 |
| 26. INSTRUMEN                     |                   |        |                      |         | ,                 |       |                   |       |       |      | 27.<br>SECURITY |
| IMAGER.                           | 1-INCH AUTOMA     | AT IC- | -PICTURE-TRAI        | V SM I  | SSION             | VI    | DICOI             | V     |       |      | UNC             |
| 28. APPLICATIO                    | N                 |        |                      | 12      | 9. SPACE          | CRAF  | Т                 |       |       |      |                 |
| MET                               |                   |        |                      |         | NIMBU:            | 5 1   |                   |       |       |      |                 |
| 30. PURPOSE                       |                   |        |                      |         |                   |       |                   |       |       |      |                 |
| PRIMARY-                          | TO PROVIDE RI     | EAL-   | TIME WIDE-AND        | GLE     | CLOUD             | COV   | VER I             | PIC   | TUF   | ₹ES  | FOR             |

USE BY LUCAL USERS.\*\*\*SECONDARY-CHECKOUT FOR SENSORS TO BE USED IN FUTURE OPERATIONAL TOS FLIGHTS.

## 31. PRINCIPLES OF OPERATION

THE APT SYSTEM, CUNSISTING OF A 1-IN VIDICON ARRANGEMENT, WAS TEST FLOWN ON TIRUS 8 AND NIMBUS 1 AND 2 (1 CAMERA). PRIOR TO OPERATIONAL TOS FLIGHTS (ESSA 2,4,6) AND TIROS M (2 CAMERAS). THE VIDICON USED INITIALLY (TIPOS 8 AND NIMBUS 1). HAD A DI-ELECTRIC LAYER DEPOSITED ON THE GUN SIDE OF THE PHOTOCONDUCTOR TO STORE THE SCENE INFORMATION. HOWEVER, SINCE THE ELECTRON BEAM ALTERED THE ELECTRIC PROPERTIES OF THIS SURFACE, THE VIDICON WAS UPGRADED FOR FUTURE FLIGHTS. THE CAMERA UTILIZES A TEGEA-KINDP-TIC, 108-DEG, WIDE ANGLE, F/1.8 OBJECTIVE LENS WITH A 5.7 MM FL. THE SYSTEM AUTOMATICALLY TAKES AND TRANSMITS A PICTURE EVERY 208 SECS WHILE THE SATELLITE IS IN DAYLIGHT. OPTICAL EXPOSURE TIME IS 40 MILLISEC, GIVING SMEAR OF LESS THAN 10 PERCENT OF ONE PIC-AN 8-SECOND TURN-ON AND SYNC-SIGNAL PRECEDES THE TURE ELEMENT. 200 SECOND TRANSMISSION, AT WHICH TIME THE VIDICON IS SCANNED AT 4 LINES PER SEC, PRODUCING AN 800-LINE PICTURE WITH SCAN LINES PERPENDICULAR TO THE ORBIT TRACK. A 5-WATT TV TRANSMITTER BROAD-CASTS THE SIGNAL IN THE 136.95 MHZ BAND. AN APT GROUND STATION WITH AN APPROPRIATE ANTENNA, RECEIVER, AND A RECORDER CAN RE-CEIVE THESE PICTURES WHEN THE SPACECRAFT IS WITHIN ACQUISITION RANGE. APT IS COMPATIBLE WITH COMMERCIAL 240 RPM FAX EQUIPMENT.

#### 32. PHENOMENA OBSERVED

CLOUD AND TERRAIN FEATURES OF APPROX 1.7 NM OR LARGER

## 33. MEASUREMENT RANGE

DYNAMIC PICTURE RANGE OF 10:1

## 34. PRECISION AND ACCURACY

TO 10 LEVELS OF BRIGHTNESS VARIATION

| 35. SPECTRAL RANGE                              |                           | 36. SPECTRAL RESOLU | JTION 37. TIME CONSTANT  |
|---|---------------------------|---------------------|--|
| 0.45 TO 0.65                                    | MICRON                    | NA                  |  |
| 38. FIELD OF VIEW                               | 39. GROUND SW             |                     |  |
|   |                           | 15 NM FROM 600      | NM ALTITUDE  |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESO         |                           |                     |  |
| 0.162 DEG APPROXIMA                             | <del></del>               |                     | ·····  |
| 42. POINTING ACCURACY 43. POINTING RATE         |                           |                     | INCLINATION  |
|   | G/SEC MED                 | ECCENTRIC SU        | N-SYNCH RETROGRADE   |
| 46. SPECIAL REQUIREMENTS                        |                           |                     |  |
| 47. COMPONENTS                                  |                           |                     |  |
| VIDICON, ELECTRONICS,                           | FRANSMITTE                | R. TAPE RECOR       | DER  |
| 48. WEIGHT 49. VOLUME                           | 50. AVERAGE POW           |                     |  |
| 30 LB   |                           |                     | 40 WATTS 200 HRS   |
|   | ICLEAR<br>RFERENCE 57. IN | THERMAL 58. SHIEL   | ······································   |
| SENSITIVE SENSITIVE                             |                           |                     | TIC SHIELDING USED   |
| 59. CALIBRATION                                 | 60. DATA RE               |                     | 61. FREQUENCY OF OBSERVATION   |
| FIDUCIAL MARKS INCLUDE                          | PEALTIM                   | E TELEMETRY         | CONTINUOUS DAYTIME   |
| 62. TELEMETRY REQUIREMENTS                      |                           |                     |  |
| PICTURE IS COMMUNICATE                          |                           |                     |  |
| BAND OF 136-137 MHZ. TI                         | C OBDIV BH                | UTPUT REQUIRE       | S 4000 HZ MAXIMUM  |
| FREQUENCY CAPABILITY.                           |                           |                     | The state of the s |
| 63. ADVANTAGES AND LIMITATIONS                  |                           |                     |  |
| DIRECT TRANSMISSION ON                          | = '                       |                     |  |
| MEDIATE STORAGE. DIFLE                          | CTRIC SURF                | ACE OF VIDICO       | N LIMITED TUBELIFE.  |
| 64. REFERENCES                                  | 1050 107                  | / NACA CD 0/        |  |
| 1)SIG ACHIEV IN SAT ME                          |                           |                     |  |
| AND STROUD, W.G.: THE ASSMPTE, VOL 73, FEB 1969 |                           |                     | •  |
| REVIEW OF A DECADE OF S                         |                           | •                   | · ·  |
| EOROLOGY. PRESENTED AT                          |                           |                     |  |
| ***4)BALAKRISHNAN: ADV                          |                           |                     |  |
| 65. HISTORICAL REMARKS                          |                           | <u> </u>            |  |
| SIMILAR TO APT ON NIMBU                         | JS 2;ESSA                 | 2,4,6;TIROS 8       | ; SCHED FOR TIROS M  |
|   |                           |                     |  |
|   |                           |                     |  |
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## NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771

|   |                   |        |                    |             |               |     |                   |                   | _      |                 |  |  |
|---|-------------------|--------|--------------------|-------------|---------------|-----|-------------------|-------------------|--------|-----------------|--|--|
| 1. TITLE  |                   |        |                    |             |               |     | 2.                | ACRONY            | 1 3. E | EXP NO          |  |  |
| AUTOMATIC   | PICTURE-TRA       | NSMI   | ISSION SYSTEM      | 4           |               |     | A                 | PT                |        |                 |  |  |
| (TITLE CONT.                                      | ) , ,             |        |                    |             |               |     | 4.1               | RESUME DAT        | Έ      | 5.<br>VERSION   |  |  |
|   |                   |        | 4                  |             |               |     | ্                 | 9/01/             | 72     | 0005            |  |  |
| 6. PRINCIPAL II                                   | VESTIGATOR        | 7. OR  | GANIZATION         | ELEPHO      | ONE           | ,   |                   |                   |        |                 |  |  |
| MOODY, J.   | ENTER             | 301    | 1-98               | 2-504       | 2             |     |                   |                   |        |                 |  |  |
| 9. CO-INVESTIGATOR 10. ORGANIZATION 11. TELEPHONE |                   |        |                    |             |               |     |                   |                   | -      |                 |  |  |
|   |                   |        |                    |             | 15. START     |     |                   |                   |        |                 |  |  |
| 12. CONTRACT<br>TYPE                              | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | 16. C       | 17. STATUS    |     |                   |                   |        |                 |  |  |
| -   |                   |        |                    |             |               |     |                   | POST              | FL     | IGHT            |  |  |
| 18. MONITOR                                       |                   | 19. AG | ENCY               | 21. 1       | 21. TELEPHONE |     |                   |                   |        |                 |  |  |
| HALEY, DE   | <b>≀.</b> R.      | NASA   | HDQTRS             | OA/         | ERN           | 202 | 2-75              | -755-2322         |        |                 |  |  |
| 22. VENDOR  |                   |        | 23. LOCATION       |             |               |     | 24. FLIGH<br>DATE | <sup>17</sup> 25. | LEAD   | TIME            |  |  |
| RCA ASTRO   | D-ELECTRONICS     | ,      | PRINCETON, A       | <b>V.J.</b> | - '           | -   | 05/               | 66 NA             |        |                 |  |  |
| 26. INSTRUMEN                                     | T TYPE            |        |                    |             |               |     |                   |                   |        | 27.<br>SECURITY |  |  |
| IMAGER, 1   | 1-INCH AUTOMA     | TIC-   | -PICTURE-TRAI      | NSMI        | SSION         | VII | DICO              | N                 |        | UNC             |  |  |
| 28. APPLICATION 29. SPACECE                       |                   |        |                    |             |               |     |                   |                   |        |                 |  |  |
| MET   |                   |        |                    |             | NIMBUS        | 5 2 |                   |                   |        |                 |  |  |
| 30. PURPOSE                                       |                   |        |                    |             | <u> </u>      |     |                   | <del></del>       |        |                 |  |  |

PRIMARY-TO PROVIDE REAL-TIME WIDE-ANGLE CLOUD COVER PICTURES FOR USE BY LOCAL USERS.\*\*\*SECONDARY-CHECKOUT FOR SENSORS TO BE USED IN FUTURE OPERATIONAL TOS FLIGHTS.

#### 31. PRINCIPLES OF OPERATION

THE APT SYSTEM WAS TEST FLOWN IN VARIOUS MODES OF SOPHISTICATION ON TIROS 8 AND NIMBUS 1 AND 2, PRIOR TO OPERATIONAL TOS FLIGHTS (ESSA 2,4,6) AND TIROS M. NIMBUS 2 USED A SINGLE 1-INCH CAMERA VIDICON ARRANGEMENT DESIGNED TO OPERATE FROM A SPIN STABILIZED SPACECRAFT. THIS CAMERA HAD AN IMPROVED LONG STORAGE TIME PHOTO-CONDUCTOR. THE CAMERA UTILIZED A TEGEA-KINOPTIC, 108-DEGREE, WIDE ANGLE. F/1.8 OBJECTIVE LENS WITH A FOCAL LENGTH OF 6.0 MM. THE SYSTEM AUTOMATICALLY TAKES AND TRANSMITS A PICTURE EVERY 208 SECS WHILE THE SATELLITE IS IN DAYLIGHT. OPTICAL EXPOSURE TIME IS 40 MILLISECONDS, GIVING SMEAR OF LESS THAN 10 PERCENT OF ONE PICTURE ELEMENT. AN 8-SECOND TURN-ON AND SYNC SIGNAL PRECEDES THE 200 SEC TRANSMISSION. DURING THIS LATTER PERIOD, THE VIDICON IS SCANNED AT FOUR LINES PER SECOND, AND THE SIGNALS TRANSMITTED PRODUCING AN 800-LINE PICTURE WITH SCAN LINES PERPENDICULAR TO THE ORBIT TRACK. A 5-WATT TV TRANSMITTER BROADCASTS THE SIGNAL IN THE 136.95 MHZ SPACE TELEMETRY BAND. AN APT GROUND STATION WITH AN APPROPRIATE ANTENNA, RECEIVER, AND A RECORDER COMPATIBLE WITH SLOW SCAN TV TRANSMISSION CAN RECEIVE THESE PICTURES WHEN THE SPACECRAFT IS WITHIN ACQUISITION RANGE. THE SYSTEM IS COMPA-TIBLE WITH COMMERCIAL 240 RPM FACSIMILE EQUIPMENT.

## 32. PHENOMENA OBSERVED

CLOUD AND TERRAIN FEATURES OF 2 NM OR LARGER

## 33. MEASUREMENT RANGE

DYNAMIC PICTURE RANGE OF 25:1

## 34. PRECISION AND ACCURACY

10 LEVELS OF GREY; 30-DB S/N AT 0.7 FOOT-CANDLES/SEC

| 35. SPECTRAL RANGE                      |                 | 36. SPECTRAL RESOI           | UTION         | 37. TIME CONSTANT     |
|---|-----------------|------------------------------|---------------|-----------------------|
| 0.45 TO 0.65                            | MICRON          | NΔ                           |               |                       |
| 38. FIELD OF VIEW                       | 39. GROUND SWA  | тн                           |               |                       |
| 89.0 BY 89.0 DEG                        | 1200 NM B       | <u>Y 1200 NM FR</u>          | <u> 38 MC</u> | O NM ALTITUDE         |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESO |                 |                              |               |                       |
| C.162 DEG 1.7 NM FRI                    | OM 600 NM       | ALTITUDE                     |               |                       |
| 42. POINTING ACCURACY 43. POINTING RATE | 44. ALT         | TUDE 45                      | INCLINA       | TION                  |
| 1.0 DEG 0.1 DE                          | G/SEC MED       | CIRCULAR S                   | UN-SY         | NCH RETROGRADE        |
| 46. SPECIAL REQUIREMENTS                | •               |                              |               |                       |
|   |                 |                              |               |                       |
| 47. COMPONENTS                          |                 | *                            |               |                       |
| VIDICON, ELECTRONICS,                   | <u> </u>        | R, TAPE RECO                 | RDER          |                       |
| 48. WEIGHT 49. VOLUME                   | 50. AVERAGE POW | R 51. STANDBY POWER          | 52. PEA       | K POWER 53. MTBF      |
| 30 LB                                   |                 |                              | 40            | WATTS 6 MON           |
|   | JCLEAR 57. INT  | HERMAL<br>REFERENCE 58. SHIE | LDING         |                       |
| SENSITIVE SENSITIVE                     |                 | MAGN                         | ETIC          | SHIELDING USED        |
| 59. CALIBRATION                         | 60. DATA REC    | OVERY                        | 61. FRE       | QUENCY OF OBSERVATION |
| FIDUCIAL MARKS INCLUDED                 | <u> </u>        | E TELEMETRY                  | CON           | TINUNUS DAYTIME       |
| 62. TELEMETRY REQUIREMENTS              |                 | ·                            |               |                       |
| PICTURE IS COMMUNICATED                 | TO AN EA        | RTH STATION                  | IN TH         | E SPACE RES.          |
| BAND OF 136-137 MHZ. TH                 | HE VIDEO O      | JTPUT REQUIR                 | ES 40         | MUMIKAM SH CO         |
| FREQUENCY CAPABILITY.                   |                 |                              |               |                       |
| 63. ADVANTAGES AND LIMITATIONS          |                 |                              |               |                       |
| IMPROVEMENTS OVER PRIOR                 | APT RELI        | ABILITY, PER                 | ORMAI         | NCE, AND LIFE         |
| CHARACTERISTICS.                        |                 |                              |               |                       |
| 64. REFERENCES                          |                 |                              |               |                       |
| 1) SIG ACHIEV IN SAT ME                 | T 1958-19       | 54, NASA SP-                 | 96.**         | *2) STAMPFL. R.       |
| A. AND STROUD, W.G.: TH                 | IE APT TV       | AMERA SYSTE                  | 1 FOR         | MET SATS. JOUR        |
| SMPTE, VOL 73, FEB 1964                 |                 |                              |               |                       |
| JULY 1966. * * * 4) SIG ACH             |                 |                              |               |                       |
| ***5) SIG ACHIEV IN SPA                 |                 |                              |               |                       |
| ***6)BALAKRISHNAN: ADV                  |                 |                              |               |                       |
| 65. HISTORICAL REMARKS                  |                 |                              |               |                       |
| SIMILAR TO APT ON NIMBU                 | S 1:ESSA        | 2.4.6:TIRDS                  | 3 : SCHE      | D FOR TIROS M         |
|   |                 |                              | <del> </del>  |                       |
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|----------------------|-------------------|--------|--------------------|---------|---|---------------------------|-----------|--------------------|---|-----------------|
| 1. TITLE             |                   |        |                    |         |   |                           | 2. /      | ACRONYM            | 3.1                                     | EXP NO          |
| ITAMOTUA             | C PICTURE-TR.     | ANSM   | ISSION SYSTE!      | Ч       |   |                           | ΔF        | 7                  | T                                       |                 |
| (TITLE CONT          | .)                |        |                    |         | *************************************** |                           | 4. R      | ESUME DATE         |   | 5.<br>VERSION   |
|                      |                   |        |                    |         |   |                           | 0.5       | 7/01/              | 72                                      | 0006            |
| 6. PRINCIPAL I       | NVESTIGATOR       |        | GANIZATION         |         | PHONE                                   |                           |           |                    |   |                 |
| OBRIEN.              | J. (T.MON)        | GOD    | DARD SPACE FL      | LT C    | FNTER                                   | 301                       | -982      | 2-504              | 2                                       |                 |
| 9. CO-INVESTIC       | GATOR             | 10. OR | GANIZATION         |         |   | 11. T                     | ELEPHO    | NE                 |   |                 |
|                      |                   |        |                    |         |   |                           | _         |                    |   |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUME | BER    | 14. FLASH INDEX NU | MBER    | 15. START<br>DATE                       | 16. COMPLETION 17. STATUS |           |                    |   |                 |
| CPFF                 |                   |        |                    |         |   | Ţ                         |           | OPER               | ΛΤΙ                                     | UNAL            |
| 18. MONITOR          |                   | 19. AG | ENCY               | 20. PGN | A OFFICE                                | 21. T                     | ELEPHO    | ONE                |   |                 |
| GARBACZ,             | M.L.              | NAS    | A HDQTPS           | OA/     | ERO.                                    | 202-755-2322              |           |                    |   |                 |
| 22. VENDOR           |                   |        | 23. LOCATION       |         |   |                           | 24. FLIGH | <sup>7</sup> 25. l | EAD                                     | TIME            |
| RCA ASTR             | O-ELECTRONIC      | S      | PRINCETON.         | N.J.    |   | ,                         | 12/       | C NA               |   |                 |
| 26. INSTRUMEN        | IT TYPE           |        |                    |         |   |                           |           |                    |   | 27.<br>SECURITY |
| IMAGER,              | 1-INCH AUTOM.     | AT IC. | -PICTURE-TRAI      | NSMI    | SSION                                   | VIC                       | DICON     | 1                  |   | UNC             |
| 28. APPLICATIO       | ON .              |        |                    |         | 29. SPACE                               | CRAF                      | T         |                    |   |                 |
| MET                  |                   |        |                    |         | NOAA                                    | 1                         |           |                    |   |                 |
| 30. PURPOSE          |                   |        |                    |         | 1                                       |                           | -         |                    | *************************************** |                 |

PRIMARY-TO PROVIDE METEOROLOGISTS WITH DAYTIME OBSERVATIONS OF CLOUD COVER AS DETECTED IN THE VISIBLE SPECTRUM FOR DIRECT TRANSMISSION TO USERS LOCATED AROUND THE WORLD.\*\*\*SECONDARY-TO EXPAND THE OPERATIONAL CAPABILITY OF THE BASIC TOS SYSTEM.

#### 31. PRINCIPLES OF OPERATION

THE APT CAMERA SUBSYSTEM HAS ALSO BEEN FLOWN PREVIOUSLY ON TIROS 8, NIMBUS 1.2; ESSA 2,4.6 AND ITOS 1 IN SIMILAR CONFIGURATION. THE SUBSYSTEM WILL CONSIST OF 2 IDENTICAL 1-INCH VIDICON APT CAM ERAS, EACH UTILIZING A TEGRA-KINOPTIC, 108-DEG, WIDE-ANGLE, F/1.8 OBJECTIVE LENS WITH A FOCAL LENGTH OF 5.7 MM. ONLY ONE CAMERA IS UTILIZED FOR OPERATION DURING ANY PICTURE-TAKING SEQUENCE. THE APT SUBSYSTEM IS CONTROLLED BY GROUND-INITIATED COMMANDS THAT ARE TRANSMITTED TO AND STORED BY THE SATELLITE.ONCE THE SEQUENCE IS INITIATED. THE CAMERA WILL TAKE A PICTURE ONCE EVERY 260 SEC UNTIL THE PRESCRIBED 11 PICTURES HAVE BEEN TAKEN. THE ACTUAL PICTURE TAKING REQUIRES 8 SEC WITH AN EXPOSURE TIME OF 25 MILLI-SEC, AND THE TRANSMISSION 150.SECS. DURING THIS LATTER PERIOD THE VIDICON IS SCANNED AT 4 LINES PER SEC, AND THE SIGNALS TRANSMITTED PRODUCING AN 600-LINE PICTURE WITH SCAN LINES PER-PENDICULAR TO THE ORBIT TRACK. TWO 5-WATT TV TRANSMITTERS ARE USED, EACH PROVIDING A 137.62 MHZ CARRIER. AN APT GROUND STATION WITH AN APPROPRIATE ANTENNA, RECEIVER, AND A RECORDER CAN RE-CEIVE THESE PICTURES WHEN THE SPACECRAFT IS WITHIN ACQUISITION RANGE.

## 32. PHENOMENA OBSERVED

CLOUD AND TERRAIN FEATURES OF APPROX 3.4 NM OR LARGER

## 33. MEASUREMENT RANGE

DYNAMIC PICTURE RANGE OF 20:1

## 34. PRECISION AND ACCURACY

S/N OF 32 CB, MINIMUM; 8 GRAY LEVELS CAN BE RESOLVED

| [05 00 5 = 5 = 5       |        |                        |             |        |                    |              |          |               |         |          |            |          | T            |        |             |          |
|------------------------|--------|------------------------|-------------|--------|--------------------|--------------|----------|---------------|---------|----------|------------|----------|--------------|--------|-------------|----------|
| 35. SPECTRAL           |        |                        |             | 4 E    | 14 1               | ( C () (     |          |               | PECTRA  | AL RE    | SOLU       | JTION    |              | IME (  |             | CONDS    |
| 0.45<br>38. FIELD OF V |        | 0                      | <u> </u>    | 65     |                    |              | ONS I    |               |         |          |            |          | 1 20         | 20 ·   | - 30        | - COMP 3 |
|                        |        | 90 (                   | · -         |        |                    |              | D SWAT   |               | 00 6    | IM E     | רכו        | vi 7     | 50 NM        | , A1   | 777         | TIDE     |
| 89.7 {                 | BY     | 89.6                   |             |        |                    |              | T DT     | <u> </u>      | OO r    | A ial L  | · K J !    | <u> </u> | 30 N         | . 14.1 |             | TOO C    |
| 0.25                   |        | 3.4                    |             |        |                    |              | NE A     | <u> </u>      | ENT     | - O - C  | רם         | M 7      | 50 NA        | . ΑΙ   | TI          | TUDE     |
| 42. POINTING ACCU      | T      | <del></del>            |             |        |                    |              | ALTIT    |               |         | - 1      |            |          | NATION       |        | - , ,       | TODE     |
| 42. FORWTHING ACCO     | JAACT  | 43. FUII               | 411140      | DAIL   | :                  |              |          |               | CULA    | \ P      |            |          | YNCH         |        | -TRI        | GRADE    |
| 46. SPECIAL RE         | OUR    | MENTS                  |             |        |                    | L'           |          | <i>y</i> 1 11 | COL     |          | 30         | • -      | 111011       |        |             | 3077406  |
|                        |        |                        |             |        |                    |              |          |               |         |          |            |          |              |        |             |          |
| 47. COMPONEN           | TS     |                        |             |        |                    |              |          |               |         |          |            |          |              |        |             |          |
| CAMERAS                | (2),   | ELEC                   | CTRO        | NIC    | S (2               | 2)           |          |               |         |          |            |          | <u> </u>     |        |             |          |
| 48. WEIGHT             | 49. V  | DLUME                  |             |        | 50. A              | /ERAC        | GE POWER | 5             | . STAND | BY POV   | VER        | 52. PE   | AK POV       | VER    | 53. I       | MTBF     |
| 45 LB                  |        | 2.0                    | СŪ          | JFT    |                    | 7            | WATT:    | 5             | ,       |          |            | 210      | TAW C        | TS     | ]           | LYEAR    |
| 54. INTERFERENCE       | 55. IN | MAGNETIC<br>TERFERENCE |             | 56. NI | UCLEAR<br>RFERENCE |              | 57. THE  | RMAL<br>FEREN | E       | 58. S    | HIEL       | DING     |              |        |             |          |
| SENSITIVE              | FSE    | NSIT                   | IVE         |        |                    |              |          |               |         |          |            |          |              |        |             |          |
| 59. CALIBRATION        | ON     |                        |             |        | 60.                | DAT          | A RECC   | VEF           | Y       |          |            |          | REQUENC      |        |             |          |
|                        | ·      |                        |             |        | RE                 | ΔL           | TIME     | TE            | LFME    | TRY      |            | DA'      | YTIME        | 01     | <u>v 20</u> | DMAMMC   |
| 62. TELEMETR           |        |                        |             |        |                    |              |          |               |         |          |            |          |              |        |             |          |
| THE VIDEO              |        |                        |             |        | -                  |              |          |               |         |          |            |          |              |        |             |          |
| WHOSE AMI              |        |                        |             |        |                    |              |          | ) H           | ız sı   | JBC A    | <b>LRR</b> | [ER      | , WHI        | CH     | IN          | TURN     |
| MODULATES              |        |                        |             |        | ZCA                | ARR          | IEB.     |               |         |          |            |          |              | ****   |             |          |
| 63. ADVANTAG           |        |                        |             |        |                    |              | <u> </u> |               | C T     | . *      |            |          | FF0 1        | 17.1.4 | 0.1         | 11000    |
| AN IMPROV              | . –    |                        |             |        |                    |              |          |               | -       |          |            |          |              |        |             |          |
| ON THIS A              |        | REV                    | <u> 15t</u> | ) 11   | MINO               | <u>, 1 !</u> | O PK     | <u> </u>      | טב ו    | L I F    | 16         | IUKI     | 22 FR        | UM     | 1 (         | JAMERA   |
| 1) DESIGN              |        | חע מ                   | - 00 0      | ) T C  | 00 1               |              | TUDI     | 201           | ED 1    | <u> </u> | 111        | 761      | CVCT         | CN     | V/O 4       | 1 2      |
| RCA ASTR               |        |                        |             |        |                    |              |          |               |         |          |            |          |              |        | •           |          |
| APT USER               |        |                        |             |        |                    |              |          |               |         |          |            |          |              |        |             |          |
| R.A. AND               |        |                        |             |        |                    |              |          |               |         |          |            |          |              |        |             |          |
| NASA THE               |        | -                      |             |        |                    |              |          |               |         |          |            |          |              |        |             |          |
| OT-2. PC               |        | •                      | -           |        |                    |              | • • •    |               | · L :   | 1011     | • • • •    |          | , <u>.</u> . | O I    | • •         | (,,,,,   |
| 65. HISTORICA          |        |                        |             |        |                    | <u>'</u>     |          |               |         |          | _          |          | ,            |        |             |          |
| SEE ITEN               | 4 31   |                        |             |        |                    |              |          |               |         |          |            |          |              |        |             |          |
|                        |        |                        |             |        |                    |              |          |               |         |          |            |          |              |        |             |          |
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|                        |        |                        |             |        |                    |              |          |               |         |          |            |          |              |        |             |          |
|                        |        |                        |             |        |                    |              |          |               |         |          |            |          |              |        |             |          |
|                        |        |                        |             |        |                    |              |          |               |         |          |            |          |              |        |             |          |
| c                      |        |                        |             |        |                    |              |          |               |         |          |            |          |              |        |             |          |
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|                        |        |                        |             |        |                    |              |          |               |         |          |            |          |              |        |             |          |
|                        |        |                        |             |        |                    |              |          |               |         |          |            |          |              |        |             |          |
|                        |        |                        |             |        |                    |              |          |               |         |          |            |          |              |        |             |          |
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|                        |        |                        |             |        |                    |              |          |               |         |          |            |          |              |        |             |          |
|                        |        |                        |             |        |                    |              |          |               |         |          |            |          |              |        |             |          |
|                        |        |                        |             |        |                    |              |          |               |         |          |            |          |              |        |             |          |
|                        |        |                        |             |        |                    |              |          |               |         |          |            |          |              |        |             |          |
|                        |        |                        |             |        |                    |              |          |               |         |          |            |          |              |        |             |          |
|                        |        |                        |             |        |                    |              | •        |               |         |          |            |          |              |        |             |          |
|                        |        |                        |             |        |                    |              |          |               |         |          |            |          |              |        |             |          |

| 1. TITLE  |                   |        |                           |        |                   |                  | 2. /                  | ACRONYM    | 3.1 | EXP NO          |  |
|---|-------------------|--------|---------------------------|--------|-------------------|------------------|-----------------------|------------|-----|-----------------|--|
| AUTOMATIO   | C PICTURE-TRA     | NSM!   | ISSION SYSTEM             | 4      |                   |                  | AF                    | 7          |     |                 |  |
| (TITLE CONT.                                      | )                 |        |                           |        |                   |                  | 4. R                  | ESUME DATE |     | 5.<br>VERSION   |  |
|   |                   |        |                           |        |                   |                  | 0.9                   | 7017       |     | 0004            |  |
| 6. PRINCIPAL II                                   | VVESTIGATOR       | 7. OR  | ORGANIZATION 8. TELEPHONE |        |                   |                  |                       |            |     |                 |  |
| STAMPFL,  | DR. R.A.          | GODE   | DARD SPACE FL             | _ T C  | ENTER             | 301              | -982                  | -504       | 2   |                 |  |
| 9. CO-INVESTIGATOR 10. ORGANIZATION 11. TELEPHONE |                   |        |                           |        |                   |                  |                       |            |     |                 |  |
|   |                   |        |                           |        |                   |                  |                       |            |     |                 |  |
| 12. CONTRACT<br>TYPE                              | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU        | MBER   | 15. START<br>DATE | 16. <sup>C</sup> | COMPLETION 17. STATUS |            |     |                 |  |
|   |                   |        |                           |        |                   |                  |                       | POST       | FL  | IGHT            |  |
| 18. MONITOR                                       |                   | 19. AG | ENCY                      | ELEPHO | ONE               |                  |                       |            |     |                 |  |
| TEPPER, 1   | ٧.                | NASA   | A HDQTRS                  | OA/    | ERD               | 202-755-2322     |                       |            | 2   |                 |  |
| 22. VENDOR  |                   |        | 23. LOCATION              |        |                   |                  | 24 FLIGHT<br>DATE     | 25. 1      | EAD | TIME            |  |
| RCA ASTR  | D-ELECTRONICS     | 3      | PRINCETON, 1              |        | 12/6              | 3 NA             |                       |            |     |                 |  |
| 26. INSTRUMEN                                     | T TYPE            |        | <b>,</b>                  |        |                   |                  |                       |            |     | 27.<br>SECURITY |  |
| IMAGER,   | I-INCH AUTOMA     | TIC-   | -PICTURE-TRAN             | IMSV   | SSION             | VII              | DICON                 | 1          |     | UNC             |  |
| 28. APPLICATIO                                    | N                 |        |                           |        | 29. SPACE         | CRAF             | 7                     |            |     |                 |  |
| MET   |                   | -      |                           |        | TIROS             | 8 -              |                       |            |     |                 |  |
| 30. PURPOSE                                       |                   |        |                           |        |                   |                  |                       |            |     |                 |  |

PRIMARY-TO PROVIDE REAL TIME WIDE-ANGLE CLOUD COVER PICTURES FOR USE BY LOCAL USERS.\*\*\*SECONDARY-TO CHECKOUT SENSORS TO BE USED IN FUTURE OPERATIONAL TOS FLIGHTS.

## 31. PRINCIPLES OF OPERATION

THE APT SYSTEM, CONSISTING OF A 1-IN VIDICUM ARRANGEMENT, WAS TEST FLOWN ON TIROS 8 AND NIMBUS 1 AND 2 (1 CAMERA), PRIOR TO OPERATIONAL TOS FLIGHTS: ESSA 2,4,6, AND TIPOS M (2 CAMERAS). THE VIDICON USED INITIALLY (TIROS 8 AND NIMBUS 1), HAD A DIELEC-TRIC LAYER DEPOSITED ON THE GUN SIDE OF THE PHOTOCONDUCTOR TO STORE THE SCENE INFORMATION. HOWEVER, SINCE THE ELECTRON BEAM ALTERED THE ELECTRIC PROPERTIES OF THIS SURFACE, THE VIDICON WAS UPGRADED FOR FUTURE FLIGHTS. THE CAMERA UTILIZES A TEGEA-KINDP-TIC, 108-DEG, WIDE-ANGLE, F/1.8 OBJECTIVE LENS WITH A 5.7 MM FL. THE SYSTEM AUTOMATICALLY TAKES AND TRANSMITS A PICTURE EVERY 208 SECS WHILE THE SATELLITE IS IN DAYLIGHT. OPTICAL EXPOSURE TIME IS 40 MILLISEC, GIVING SMEAR OF LESS THAN 10 PERCENT OF ONE PIC-TURE ELEMENT. AN 8-SECOND TURN-ON AND SYNC SIGNAL PRECEDES THE 200-SECOND TRANSMISSION, AT WHICH TIME THE VIDICON IS SCANNED AT 4 LINES PER SEC, PRODUCING AN 800-LINE PICTURE WITH SCAN LINES PERPENDICULAR TO THE ORBIT TRACK. A 5-WATT TV TRANSMITTER BROADCASTS THE SIGNAL IN THE 136.95 MHZ BAND. AN APT GROUND STA-TION WITH AN APPROPRIATE ANTENNA, RECEIVER, AND A RECORDER CAN RECEIVE THESE PICTURES WHEN THE SPACECRAFT IS WITHIN ACQUISITION RANGE. APT IS COMPATIBLE WITH COMMERCIAL 240 RPM FAX EQUIPMENT.

#### 32. PHENOMENA OBSERVED

CLOUD AND TERRAIN FEATURES APPROXIMATELY 1.7 NM OR LARGER

## 33. MEASUREMENT RANGE

DYNAMIC PICTURE RANGE OF 10:1

## 24. PRECISION AND ACCURACY

6 TO 10 LEVELS OF BRIGHTNESS VARIATION

| 35. SPECTRAL RANGE   | 36. SPECTRAL RESOLU                 | JTION 37. TIME CONSTANT                          |
|--|-------------------------------------|--|
| 0.45 TO 0.65   | MICRON NA                           |  |
| 38. FIELD OF VIEW  | 39. GROUND SWATH                    |  |
| 89.0 BY 89.0 DEG   | 1200 NM BY 1200 NM FRO              | M 450 NM ALTITUDE                                |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION  | DLUTION                             |  |
| 0.16 DEG 1.7 NM FR   | OM 450 NM ALTITUDE                  |  |
| 42. POINTING ACCURACY 43, POINTING RATI  | 44. ALTITUDE 45.                    | INCLINATION                                      |
| 1.0 DEG 0.1 DE   | SISEC MED CIRCULAR ME               | DIUM POSIGRADE                                   |
| 46. SPECIAL REQUIREMENTS   |                                     |  |
|  |                                     |  |
| 47. COMPONENTS   | <u> </u>                            |  |
| VIDICON, ELECTRONICS,  | TRANSMITTER. TAPE RECOR             | DER  |
| 48. WEIGHT 49. VOLUME  | 50, AVERAGE POWER 51. STANDBY POWER |  |
| 24 LB  | SU. AVERAGE POWER ST. STANDET FOWER | 40 WATTS 200 HRS                                 |
|  | UCLEAR S7. INTERMAL S8. SHIEL       |  |
| The same and the s |                                     |  |
| SENSITIVE SENSITIVE  |                                     | TIC SHIELDING USED  61. FREQUENCY OF OBSERVATION |
| 59. CALIBRATION  | 60. DATA RECOVERY                   |  |
| FIDUCIAL MARKS INCLUDE   | D REALTIME TELEMETRY                | CONTINUOUS DAYTIME                               |
| 62. TELEMETRY REQUIREMENTS   |                                     | * .  |
| PICTURE IS COMMUNICATE   |                                     |  |
| SEARCH BAND OF 136-137   | MHZ. THE VIDEO OUTPUT               | REQUIRES 4 KHZ MAX-                              |
| IMUM BANDWIDTH CAPABIL   | ITY.                                |  |
| 63. ADVANTAGES AND LIMITATIONS   |                                     |  |
| DIRECT TRANSMISSION ON   | COMMAND TO MANY RECEIV              | ERS WITHOUT INTER-                               |
| MEDIATE STORAGE. DIELE   | CTRIC SURFACE OF VIDICO             | N LIMITED TUBELIFE.                              |
| 64. REFERENCES   |                                     |  |
| 1) SIG ACHIEV IN SAT M   | T 1958-1964, NASA SP-9              | 6. ***2) STAMPEL. R.                             |
| A. AND STROUD, W.G.: TI  |                                     |  |
| SMPTE, VOL 73, FEB 1969  |                                     |  |
| REVIEW OF A DECADE OF  | <del>_</del>                        | •  |
| 1  |                                     |  |
| TEOROLOGY - PRESENTED A  |                                     |  |
| <del></del>  | NTATION ENGINEERS, AUG.             | 19-23, 1908.                                     |
| 65. HISTORICAL REMARKS   |                                     |  |
| SIMILAR TO APT ON NIMBI  | JS 1 AND 2, ESSA 2,4,6;             | SCHED FOR TIROS M                                |
|  |                                     |  |
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## NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT MD 20771

| ,      | GITEEIADEET, MO.                                  |  |   |  |   |           |                  |                 |  |
|--------|---|--|---|--|---|-----------|------------------|-----------------|--|
|        |   |  |   |  | 2.4   | CRONYN    | 3.               | EXP NO          |  |
| TEM    |   |  |   |  | D   | NC S      | <u> </u>         |                 |  |
|        |   | •  |   |  | 4. R  | ESUME DAT | Ē                | 5.<br>VERSION   |  |
|        |   |  |   |  | 0   | 9/01/     | 772              | 0004            |  |
| 7. OR  | 7. ORGANIZATION 8. TELEPHONE                      |  |   |  |   |           |                  |                 |  |
| GOD    | DARD SPACE F                                      | LT C   | ENTER   | 30   | 1-98  | 2-504     | +2               |                 |  |
| 10. OR | GANIZATION  |  |   | 11. T  | ELEPHO  | EPHONE    |                  |                 |  |
|        |   |  |   |  |   |           |                  |                 |  |
| BER    | 14. FLASH INDEX NU                                | MBER   | 15. START<br>DATE   | 16. <sup>C</sup>   | OMPLETION<br>DATE   | 17. STA   | TUS              |                 |  |
|        |   |  |   | Ú  | 8/68  | POST      | F                | LIGHT           |  |
| 19. AG | ENCY  | 21. TELEPHONE  |   |  |   |           |                  |                 |  |
| NAS    | A HDQTRS  | OAZ  | 'ECS  | 20   | 2-75  | 5-23      | 22               |                 |  |
|        | 23. LOCATION                                      |  |   |  | 24. FLIGHT<br>DATE  | 25.       | LEAC             | TIME            |  |
| S      | PRINCETON.  | NEW  | JERSE   | Υ  | 08/   | 68 N      | 7                |                 |  |
|        |   |  |   |  |   |           |                  | 27.<br>SECURITY |  |
| LE I   | MAGE-ORTHICO                                      | N  |   |  |   |           |                  | UNC             |  |
|        |   | 2  | 29. SPACE   | CRAF   | T   |           |                  |                 |  |
|        | 7. ORG<br>GO D<br>10. ORG<br>BER<br>19. AG<br>NAS | 7. ORGANIZATION GODDARD SPACE F 10. ORGANIZATION BER 14. FLASH INDEX NU 19. AGENCY NASA HDQTRS 23. LOCATION S PRINCETON, | 7. ORGANIZATION GODDARD SPACE FLT CO 10. ORGANIZATION BER 14. FLASH INDEX NUMBER 19. AGENCY 20. PGN NASA HDQTRS DAY 23. LOCATION S PRINCETON, NEW LE IMAGE—ORTHICON | 7. ORGANIZATION GODDARD SPACE FLT CENTER 10. ORGANIZATION BER 14. FLASH INDEX NUMBER 15. START OATE 19. AGENCY 20. PGM OFFICE NASA HDQTRS DA/ECS 23. LOCATION S PRINCETON, NEW JERSE LE IMAGE-ORTHICON | 7. ORGANIZATION 8. TI GODDARD SPACE FLT CENTER 30 10. ORGANIZATION 11. T  BER 14. FLASH INDEX NUMBER 15. START 16. C  19. AGENCY 20. PGM OFFICE 21. T  NASA HDQTRS DA/ECS 20 23. LOCATION  S PRINCETON, NEW JERSEY  LE IMAGE—ORTHICON | 2.4   TEM | 2. ACRONYM   TEM | 2. ACRONYM   3. |  |

30. PURPOSE

MET

PRIMARY - TO EXTEND VIEWING OF EARTH'S CLOUD COVER ON A REGULAR BASIS TO INCLUDE NIGHT TIME IMAGING; TO EXAMINE OVERALL FEASI-BILITY OF A HIGH RESOLUTION CONTINUOUS SURVEILLANCE CAMERA SYSTEM OPERATING FROM SYNCHRONOUS ALTITUDE.

ATS 4

## 31. PRINCIPLES OF OPERATION

THE INCOMING LIGHT IS REFLECTED FROM THE PRIMARY MIRROR, COL-LECTED AT THE OBJECTIVE LENS AND PASSED THROUGH A BEAM-SPLITTER. IT IS THEN SIMULTANEOUSLY INCIDENT ON A PHOTOMULTIPLIER TUBE A RETRACTABLE SUNSHADE IS (PMT) AND THE IMAGE ORTHICON TUBE. AVAILABLE TO PREVENT STRAY LIGHT FROM ENTERING THE CAMERA'S FIELD OF VIEW WHILE IMAGING NIGHTTIME SCENES. THE IMAGE ORTHICON SATURATES UNDER NOMINAL FULL MOON CONDITIONS. WHEN THE SCENE ILLUMINATION IS ABOVE THIS LEVEL, ATTENUATION, IN THE FORM OF TWO TAPERED. DOUBLE CYCLE, COUNTER ROTATING NEUTRAL DENSITY FIL-TERS. IS INTRODUCED INTO THE OPTICAL PATH. THE PMT GENERATES A SIGNAL PROPORTIONAL TO THE AVERAGE SCENE ILLUMINATION OVER THE AREA VIEWED BY THE CAMERA. THE SIGNAL FROM THE PMT FEEDS AN AUTOMATIC LIGHT CONTROL CIRCUIT WHICH VARIES THE FILTERS UNTIL THE PMT SIGNAL REACHES THE DESIRED VALUE. THE OPTICS ARE STEER-ABLE BY MEANS OF GROUND COMMAND. STEPS OF 0.1 DEG THROUGH AN ANGLE OF PLUS-MINUS 12.5 DEG IN BOTH PITCH AND ROLL ARE POS-THUS THE CAMERA IS ABLE TO TRACK AREAS OF METEOROLOGICAL SIBLE. INTEREST KNOWING THE SPACECRAFT ATTITUDE AND THE LOCATION OF THE DESIRED VIEWING AREA. FULL EARTH COVERAGE CAN BE ACHIEVED BY TAKING A SERIES OF OVERLAPPING PICTURES.

## 32. PHENOMENA OBSERVED

VISIBLE LIGHT REFLECTED FROM EARTH AND CLOUD COVER

## 33. MEASUREMENT RANGE

0.0001 TO .10000 FOOT-LAMBERTS

## 34. PRECISION AND ACCURACY

800 LINES HORIZONTAL RESOLUTION, 620 LINES VERTICAL RESOLUTION

| 35. SPECTRAL RANGE   |                                | 36. SPECTRAL RESOL   | UTION 37. TIME CONSTANT      |
|--|--------------------------------|----------------------|------------------------------|
| 7.3 10 0.7   |                                | NΔ                   | 450.0 MILLS                  |
| 38. FIELD OF VIEW  | 39. GROUND SW                  |                      |                              |
|  |                                | IMB 1700 NM F        | ROM GEO-SYNCH PLT            |
| 40. ANGULAR RESOLUTION 41. SPATIAL RI                      | ·····                          |                      |                              |
| 2.005 DEG 2.16 NM<br>42. POINTING ACCURACY 43. POINTING RA |                                | ITUDE AS             | INCLINATION                  |
|  |                                |                      | DUATORIAL POSIGRAD           |
| 46. SPECIAL REQUIREMENTS                                   |                                | W STAGGERATE.        | VOLUME TO STOCKE             |
| 47. COMPONENTS   |                                |                      | · · ·                        |
| IMAGE DRIHICON, OPTIC                                      | S. SUNSHADE                    | •                    |                              |
| 48. WEIGHT 49. VOLUME                                      | 50. AVERAGE POW                | ER 51. STANDBY POWER |                              |
| 56 LB  | 21 WAT                         |                      | 48 WATTS                     |
| S4. INTERFERENCE S5. INTERFERENCE S6.                      | NUCLEAR<br>NTERFERENCE 57. INT | THERMAL 58. SHIE     | LDING                        |
| 50 CALIDRATION   | Jco 5474 55                    |                      | CA COCCUENCY OF ORCEDVATION  |
| 59. CALIBRATION  | 60. DATA REC                   |                      | 61. FREQUENCY OF OBSERVATION |
| GRAY-SCALE CALIBRATOR  62. TELEMETRY REQUIREMENTS          | 1 K FAL 11M                    | E TELEMETRY          | CONTINUOUS                   |
| 60 KHZ VIDEO BANDWIDT                                      | H                              |                      |                              |
| OS KIIZ VIDEO DANSHIDI                                     | • •                            |                      |                              |
| 63. ADVANTAGES AND LIMITATIONS                             |                                |                      |                              |
| NIGHT-TIME IMAGING.  |                                | 4.44                 |                              |
| 64. REFERENCES   |                                |                      |                              |
| 1) OSTROW, H. AND WEI                                      | NSTEIN. O.:                    | A REVIEW OF          | A DECADE OF SPACE            |
| CAMERA SYSTEMS DEVELO                                      | PEMNT FOR M                    | ETEOROLOGY: F        | RESENTED AT SOCIE            |
| OF PHOTO-OPTICAL INST                                      | RUMENTATION                    | FNGINEERS 13         | STH ANNUAL TECHNIC           |
| SYMPOSIUM, AUG. 1968.                                      |                                |                      |                              |
| PRESENTED AT ATS SYST                                      | EMS ENGINEE                    | RS TRAINING          | ROGRAM, GSEC, SEP            |
| 1966.  |                                |                      |                              |
| 65. HISTORICAL REMARKS                                     | DEACH CANCL                    | IN ON OUR ORDER      |                              |
| SPACECRAFT FAILED TO                                       | REACH SYNCH                    | RONDOS ORBIT         |                              |
| ĺ  |                                |                      |                              |
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| 1. TITLE             | 2. AC             | RONYM        | 3. E                | XP NO             |                           |              |                    |                     |     |                 |
|----------------------|-------------------|--------------|---------------------|-------------------|---------------------------|--------------|--------------------|---------------------|-----|-----------------|
| IMAGE-DIS            | SSECTOR CAMER     | <b>₹A</b> SY | /STEM               | _                 |                           |              | IDC                | S                   |     |                 |
| (TITLE CONT.         | )                 |              |                     |                   |                           |              | 4. RESL            | IME DATE            | 5   | ERSION          |
|                      |                   |              | ·                   |                   |                           |              | .09/               | 01/7                |     | 0005            |
| 6. PRINCIPAL IN      | IVESTIGATOR       | 7. OR(       | GANIZATION          | ELEPHON           | E                         |              |                    |                     |     |                 |
| BRANCHELO            | DWER. G.A.        | GODE         | DARD SPACE FL       | T CF              | ENTER                     | 301          | L-98 <b>2</b> -    | 5042                |     |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR       | GANIZATION          |                   |                           | 11. T        | ELEPHON            | E                   |     |                 |
| FOOTE, R.            | Н.                | ITT          | INDUSTRIAL L        | ABS               |                           |              |                    |                     |     |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER           | 14. FLASH INDEX NUI | 15. START<br>DATE | 16. COMPLETION 17. STATUS |              |                    |                     |     |                 |
|                      |                   |              |                     |                   |                           | 11           | 1/67 0             | PERA                | TIC | DNAL            |
| 18. MONITOR          |                   | 19. AG       | ENCY                | 21. TELEPHONE     |                           |              |                    |                     |     |                 |
| BURKE, J.            | .R.               | NASA         | A HDQTRS            | OAZE              | ECS                       | 202-755-2322 |                    |                     |     |                 |
| 22. VENDOR           |                   |              | 23. LOCATION        |                   |                           |              | 24. FLIGHT<br>DATE | FLIGHT 25. LEAD TIN |     |                 |
| ITT INDUS            | STRIAL LABS       |              | FORT WAYNE,         | IND               | IANA                      |              | 11/67              | 1/67 NA             |     |                 |
| 26. INSTRUMEN        | T TYPE            |              |                     |                   |                           |              |                    |                     |     | 27.<br>SECURITY |
| IMAGER, 1            | -INCH VISIBL      | E EL         | LECTRICALLY-S       | CAN               | VING F                    | 2H01         | <b>FOCATH</b>      | IODE                |     |                 |
| 28. APPLICATIO       | N                 |              |                     | 2                 | 9. SPACE                  | CRAF         | Т                  |                     | •   |                 |
| MET                  |                   |              |                     | $\overline{}$     | ATS 3                     |              |                    |                     |     |                 |
| 30 PURPOSE           |                   |              |                     |                   |                           |              |                    |                     |     |                 |

PRIMARY- TO TRANSMIT IN REAL TIME, DAYLIGHT CLOUD COVER INFORMA-TION FROM THE MAJOR PORTION OF THE FULL EARTH DISK, AND TO EVALUATE THE OPERATIONAL CHARACTERISTICS OF THE IDC IN A SPACE ENVIRONMENT, I.E. HOW ELECTRICAL SCANNING, AS OPPOSED TO MECHANICAL SCANNING, WILL PERFORM IN SPACE.

## 31. PRINCIPLES OF OPERATION

A SIMILAR SYSTEM IS SCHEDULED TO FLY ON NIMBUS D, AND IS FLYING ON NIMBUS 3. THE 1-INCH IMAGE DISSECTOR HAS A RESOLUTION CAPABIL-ITY OF 1300 TV-LINES. IT OPERATES IN A LINE-SCAN MODE AND CON-TAINS A PHOTOCATHODE THAT IS MASKED OFF TO FORM A SLIT SLIGHTLY WIDER THAN A LINE. A SCENE IS OPTICALLY FOCUSED ON THE PHOTO-CATHODE AND PHOTOELECTRONS ARE EMITTED FROM THE SURFACE IN PRO-PORTION TO THE INCIDENT ILLUMINATION. THE PHOTOELECTRONS ARE ACCELERATED AND FOCUSED ON A PLANE WHICH CONTAINS A PIN-HOLE APERTURE. THE ELECTRON IMAGE IS DEFLECTED PAST THE APERTURE BY MEANS OF MAGNETIC DEFLECTION. THE APERTURE SAMPLES THE ELECTRON IMAGE AND A SECONDARY-EMISSION FLECTRON-MULTIPLIER SECTION AM-PLIFIES THE SIGNAL BY ABOUT 10 MILLION. THE CAMERA IS MOUNTED WITH ITS OPTICAL AXIS PERPENDICULAR TO THE SATELLITE'S AND EARTH'S ROTATIONAL AXIS. THE CAMERA'S OPTICAL AXIS TRACES A PATH ON THE EARTH FROM WEST TO EAST AS THE SATELLITE ROTATES. THE CAMERA SCANS A PROGRESSION OF LINES, ONE PER SATELLITE ROTA-TION, UNTIL A COMPLETE RASTER IS GENERATED. COVERAGE FROM 50 N TO 50 S LATITUDE IS OBTAINED, WITH A GROUND RESOLUTION AT THE NADIR OF 3.8 NM. SCAN LINES CAN BE TRACED EITHER PARALLEL OF PERPENDICULAR TO THE SPIN AXIS OF THE EARTH.

## 32. PHENOMENA OBSERVED

REFLECTED SUNLIGHT FROM THE EARTH'S SURFACE AND CLOUD COVER

44

#### 33. MEASUREMENT RANGE

100 TO 1000 FOOT-LAMBERTS

## 34. PRECISION AND ACCURACY

40 DB AT 10,000 FOOT-LAMBERTS

| 25 0250===              | D              |                        |               |                 |                |                |                | -          |  |   |       |           |         | T        |        |   |        |                |
|-------------------------|----------------|------------------------|---------------|-----------------|----------------|----------------|----------------|------------|--|---|-------|-----------|---------|----------|--------|---|--------|----------------|
| 35. SPECTRAL            |                |                        | ^ =           |                 | 34 -           | ~ ~ ~          | <del></del> -l | 36. 9      | PECT   | RAL   | . RE  | SOLL      | JTION   | 37. T    | IME (  | ON  | STAN   | <u> </u>       |
| 0 • 4<br>38. FIELD OF \ | <del></del>    | 0                      | 0.7           |                 | MI             |                |                | T.:        |  |   |       |           |         | <u> </u> |        |   |        |                |
| <b></b>                 |                | 17. (                  | D.E.          |                 | J. GRC         |                |                |            | 1.60   | <u> </u>                                      | A114  | 1 2       | F D O M | <u> </u> | c ·    | /h: r   |        | ( <del>T</del> |
| 14.6<br>40. ANGULAR RES |                | 14.6                   |               |                 |                |                | LI             | MB         | 100  | <del>4</del> U                                | NM    | ,         | FROM    | GEL      | 1-2,   | I IV U  | , п д  | LI             |
| 0.01                    |                | 3.8 N                  |               |                 |                |                |                |            |  |   |       |           |         |          |        |   |        |                |
| 42. POINTING ACC        |                |                        |               |                 | CNI            | <del></del>    | ALTI           | THO        |  |   | ····I | ,<br>45 1 | NCLINA  | TION     |        |   | •      |                |
| Table Acc               | JAC 1          | 75. T OHT              | u n           |                 |                | -              |                |            |  | 11 4  |       |           | UATOR   |          |        | 151   | GP A   | n E            |
| 46. SPECIAL R           | EQUIR          | EMENTS                 |               |                 |                | 101            | NUT            | U          | <u>. (\                                   </u> | <u>, , , , , , , , , , , , , , , , , , , </u> | 117   | نهز       | UMIUI   | LAL      | . r.   | <u>, , , , , , , , , , , , , , , , , , , </u> | GRA    | UE             |
|                         |                |                        |               |                 |                |                |                |            |  | -   |       | -         |         |          |        |   | -      | ·              |
| 47. COMPONEN            | NTS            |                        | <del></del> , |                 |                |                |                |            | - ,  |   |       |           |         |          |        |   |        |                |
| IMAGE DI                | SSEC           | TOR, S                 | CAN           | NIN             | G AF           | PER            | TUR            | E •        | 12   | S 1   | r A G | E f       | ELECT   | TRON     | ML     | JLT   | IPL    | IER            |
| 48. WEIGHT              |                | DLUME                  | •             |                 |                |                |                |            |  |   |       |           | 52. PEA |          |        |   | мтв    |                |
| 20 LB                   |                | 0.38                   | CU            | FT              | 2 (            |                | ATT            |            |  |   |       |           |         |          |        |   |        |                |
| 54. INTERFERENCE        | 55. IN         | MAGNETIC<br>TERFERENCE | 56.           | NUCL<br>INTERFE | EAR<br>RENCE   |                | 57. INTE       | RFERE      | ice  |   | 58. S | HIEL      | DING    |          |        |   |        |                |
|                         |                |                        |               |                 |                |                |                |            |  |   |       |           |         |          |        |   |        |                |
| 59. CALIBRATI           | ON             |                        |               |                 | 60. E          | ATA            | REC            | OVE        | RY   |   |       |           | 61. FRE | QUENC    | Y OF C | BSEF  | RVATIO | N              |
|                         |                |                        |               |                 | PE             | LT             | IME            | <b>T</b> ( | ELEN   | MET   | RY    |           | EVE     | Y 1      | 0 1    | IIN   | UTE    | S              |
| 62. TELEMETR            | <del></del>    |                        |               |                 |                |                |                |            |  |   |       |           |         |          |        |   |        |                |
| LESS THA                | N 10           | O KHZ                  | ΔT            | 100             | PPN            | 1 S            | ATE            | LL         | ITE  | SF  | NI    | R A       | ATE.    |          |        |   |        |                |
|                         |                |                        |               |                 |                |                |                |            |  |   |       |           |         |          |        |   |        |                |
| 62 45165                | 050 ***        | D 1 /24/2              |               |                 |                |                |                |            |  |   |       |           |         |          |        |   |        |                |
| 63. ADVANTA             |                |                        |               |                 | <u> </u>       |                |                |            |  |   |       |           |         |          | = :=   |   |        |                |
| CAN OVER                |                |                        |               |                 |                |                |                |            | 'IN  | ДХ  | IS    | 116       | JTATI   | ON       | WIT    | Н   | PRO    | PER            |
| DATA PRO                |                | ING; D                 | AYL           | I GH            | T US           | E              | DNL            | Υ .        |  |   |       | ·         |         |          |        |   |        |                |
| 64. REFERENC            |                | urn a                  |               | 00*             |                |                |                | <u> </u>   | ~  |   |       | <b>.</b>  | 15 1-   |          |        |   | 110    |                |
| 1) BRANCI               |                |                        |               |                 |                |                |                |            |  |   |       |           |         |          |        |   |        |                |
| TECHNOLO                |                |                        |               |                 |                |                |                |            |  |   |       |           |         |          |        |   |        | _              |
| TN-4186,                |                |                        |               |                 |                |                |                |            |  |   |       |           |         |          |        |   |        |                |
| GSFC, JUI               |                |                        |               |                 |                |                |                |            |  |   |       |           |         |          |        |   |        |                |
| GSFC, 19                |                |                        |               |                 |                |                | ۲K             | U M        | 1 11   | = N   | AI    | 111       | IAL N   | ITAI     | n EK   | K   | EUU    | KU S           |
| CENTER,                 |                |                        | AIL           | LCO             | i <b>V •</b> ( | . •            |                |            |  |   |       |           |         |          |        |   |        |                |
| SIMILAR                 |                |                        | D A           | ND              | 3 11           | )( (           |                |            |  |   |       |           |         |          |        |   |        |                |
| <u> </u>                | • U 1 <b>1</b> | 111003                 | O MI          | , N U           | <i>)</i> 11    | <i>,</i> , , , | •              |            |  |   |       |           |         |          |        |   |        |                |
|                         |                |                        |               |                 |                |                |                |            |  |   | ,     |           |         |          |        |   |        | ŀ              |
|                         |                |                        |               |                 |                |                |                |            |  |   |       |           |         |          |        |   |        |                |
|                         |                |                        |               |                 |                |                |                |            |  |   |       |           |         |          |        |   |        |                |
|                         |                |                        |               |                 |                | •              |                |            |  |   |       |           |         |          |        |   |        | ļ              |
|                         |                |                        |               |                 |                |                |                |            |  |   |       |           |         |          |        |   |        |                |
|                         |                |                        |               |                 |                |                |                |            |  |   |       |           |         |          |        |   |        |                |
|                         |                |                        |               |                 |                |                |                |            |  |   |       |           |         |          |        |   |        |                |
|                         |                |                        |               |                 |                |                |                |            |  |   |       |           |         |          |        |   |        |                |
|                         |                |                        |               |                 |                |                |                |            |  |   |       |           |         |          |        |   |        |                |
|                         |                |                        |               |                 |                | •              |                |            |  |   |       |           |         |          |        |   |        |                |
|                         |                |                        |               |                 |                |                |                |            |  |   |       |           |         |          |        |   |        |                |
|                         |                |                        |               |                 |                |                |                |            |  |   |       |           |         |          |        |   |        |                |
|                         |                |                        |               |                 |                |                |                |            |  |   |       |           |         |          |        |   |        |                |
|                         |                |                        |               |                 |                |                |                |            |  |   |       |           |         |          |        |   |        |                |
| ]                       |                |                        |               |                 |                |                |                |            |  |   |       |           |         |          |        |   |        | ľ              |
| l                       |                |                        |               |                 |                |                |                |            |  |   |       |           |         |          |        |   |        |                |
|                         |                |                        |               |                 |                |                |                |            |  |   |       |           |         |          |        |   |        |                |
|                         |                |                        |               |                 |                |                |                |            |  |   |       |           |         |          |        |   |        |                |
|                         |                |                        |               |                 |                |                |                |            |  |   |       |           |         |          |        |   |        |                |
|                         |                |                        |               |                 |                |                |                |            |  |   |       |           |         |          |        |   |        |                |

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|--|-------------------|--------|---------------------------------------|---------------------------|-------------------|------|--------------------|------------|----------|-----------------|
| 1. TITLE   |                   |        |                                       |                           |                   |      | 2. A               | CRONYM     | 3. EX    | (P NO           |
| IMAGE-DIS  | SSECTOR CAMER     | ₹A SY  | STEM                                  |                           |                   |      | ΙD                 | CS         |          |                 |
| (TITLE CONT.   | )                 |        | · · · · · · · · · · · · · · · · · · · |                           |                   |      |                    | ESUME DATE |          | ERSION          |
|  |                   |        |                                       |                           |                   |      | 0.9                | 7017       | 72 (     | 0005            |
| 6. PRINCIPAL II  | NVESTIGATOR       | 7. OR  | GANIZATION                            | LEPHO                     | PHONE             |      |                    |            |          |                 |
| BRANCHFLOWER, G. GODDARD SPACE FLT CENTER 301-982-5042 |                   |        |                                       |                           |                   |      |                    |            |          |                 |
| 9. CO-INVESTIGATOR 10. ORGANIZATION 11. TELEPHONE      |                   |        |                                       |                           |                   |      |                    |            |          |                 |
|  |                   |        |                                       |                           | 15. START<br>DATE |      |                    |            |          |                 |
| 12. CONTRACT<br>TYPE                                   | 13. CONTRACT NUME | ER     | 14. FLASH INDEX NU                    | 16. COMPLETION 17. STATUS |                   |      |                    |            |          |                 |
|  | NAS5-9619         |        |                                       |                           |                   |      |                    | OPERA      | <u> </u> | INAL            |
| 18. MONITOR  |                   | 19. AG | ENCY                                  | ELEPHO                    | ONE               |      |                    |            |          |                 |
| SCHARDT.   | 8.8.              | 1.ASA  | A HDQTPS                              | DAZI                      | ERN               | 202  | 2 <del>-</del> 755 | -2322      | 2        |                 |
| 22. VENDOR   |                   |        | 23. LOCATION                          |                           |                   |      | 24. FLIGHT<br>DATE | 25. L      | EAD T    | ГІМЕ            |
| ITT INDUS  | STRIAL LABS       |        | FORT WAYNE,                           | IND                       | LANA              |      | 04/6               | 9 NA       |          |                 |
| 26. INSTRUMEN  | IT TYPE           |        |                                       |                           |                   |      |                    |            |          | 27.<br>SECURITY |
| IMAGER,  | I-INCH PHOTO      | CATH   | DDE ELECTRICA                         | ALLY-                     | -SCANI            | VING | VIS                | IBLE       |          | UNC             |
| 28. APPLICATIO   | )N                |        |                                       | 2                         | 9. SPACE          | CRAF | T                  |            |          |                 |
| MET  |                   |        |                                       | !                         | VIMBU:            | 5 3  |                    |            |          |                 |
| 30. PURPOSE  |                   |        |                                       |                           |                   |      |                    |            |          |                 |
| PPIMARY-   | TO ACQUIRE H      | I GH-F | RESOLUTION PH                         | HGT00                     | GR APH            | S OF | THE                | EAR'       | TH*S     | ,               |

## 31. PRINCIPLES OF OPERATION

DAYTIME CLOUD COVER.

THE IMAGE DISECTOR CAMERA PERFORMS THE FUNCTIONS THAT PREVIOUS-LY REQUIFED BOTH AN AVCS AND AN APT. IT HAS ALSO FLOWN ON ATS 3. BUT WITH DIFFERENT OPTICS. AND IS SCHEDULED FOR NIMBUS D. A SCENE IS OPTICALLY FOCUSED ON THE PHOTOCATHODE AND PHOTOELEC-TRONS ARE EMITTED FROM THE SURFACE IN PROPORTION TO THE INCIDENT ILLUMINATION. THE PHOTOELECTRONS APE ACCELERATED TOWARD AND FOCUSED ON A PLANE WHICH CONTAINS A PINHOLE APERTURE AT ITS CEN-TER. THE ELECTRON IMAGE IS DEFLECTED PAST THE APERTURE BY MEANS OF MAGNETIC DEFLECTION. THE APERTURE SAMPLES THE FLECTRON IMAGE AND A SECONDARY-EMISSION ELECTRON-MULTIPLIER SECTION AMPLIFIES THE SIGNAL BY ABOUT 10 MILLION. THE CAMERA IS USED IN THE LINE SCAN MODE WITH THE SPACECRAFT MOTION ALONG THE ORBITAL TRACK PROVIDING THE OTHER SCAN COMPONENT. NO SHUTTER IS REQUIRED AS THE SENSOR IS NON-STORAGE TYPE, AND EXPOSURE TO THE SCENE IS CONTINUOUS. THE VERY NARROW BANDWIDTH (1800 HZ) RESULTS IN GEN-ERATION OF A VIDEO SIGNAL WITH THE HIGH NOMINAL S/N OF 40 DB. THE CAMERA-LINE FREQUENCY IS 4 HZ WITH THE FRAME PERIOD BEING 200 SEC. THE LENS APERTURE IS FIXED AT F/3. THE GROUND RESOLU-TION IS 1.7 NM AT THE SUBSATELLITE POINT. REALTIME PICTURES CAN BE TRANSMITTED TO APT RECEIVING STATIONS.

## 32. PHENOMENA OBSERVED

VISIBLE LIGHT REFLECTED FROM EARTH AND ITS CLOUD COVER

## 33. MEASUREMENT RANGE

100 TO 10,000 FOOT-LAMBERTS

## 34. PRECISION AND ACCURACY

800 TV LINE RESOLUTION; S/N = 40 DB AT 10,000 FOOT-LAMBERTS

| 35. SPECTRAL RANGE                                 | 36. SPECTRAL RESOLUTION 37. TIME CONSTANT  |
|--|--|
| 0.4 10 0.7   | MICRON STATE RESOLUTION ST. HIME CONSTANT  |
|  | 9. GROUND SWATH  |
|  | 300 NM BY 1300 NM FROM 600 NM ALTITUDE   |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESOL           |  |
|  | ENTER FROM 600 NM ALTITUDE   |
| 42. POINTING ACCURACY 43. POINTING RATE            | 44. ALTITUDE 45. INCLINATION   |
|  | MED CIRCULAR SUN-SYNCH RETROGRADE  |
| 46. SPECIAL REQUIREMENTS                           | the same and the s |
| SPACECRAFT ATTITUDE FRED                           | RS MUST BE HELD TO VERY SMALL VALUES   |
| 47. COMPONENTS                                     |  |
| IMAGE DISECTOR, SCANNING                           | APERTURE, 12 STAGE ELECTRON MULTIPLIER   |
| 48. WEIGHT 49. VOLUME                              | 50. AVERAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF  |
| 14 LB 0.2 CU FT                                    | 12 WATTS 1 WATT  |
| S4. INTERFERENCE S5. MAGNETIC S6. NUCL S6. INTERFE | EAR THERMAL 57 INTERFERENCE 58. SHIELDING  |
| SOURC/SEN  |  |
| 59. CALIBRATION                                    | 60. DATA RECOVERY 61. FREQUENCY OF OBSERVATION   |
|  | DELAYED AND REALTIME 14 PICTURES/ORBIT   |
| 62. TELEMETRY REQUIREMENTS                         |  |
| VIDEO BANDWIDTH IS 1800                            | HZ.  |
|  |  |
|  |  |
| 63. ADVANTAGES AND LIMITATIONS                     | MESSAC EL CONTO ON MATURIOS A AND OF DEDUCES   |
| 1  | MFRAS FLOWN ON NIMBUS 1 AND 2; REDUCES   |
| NUMBER OF PICTURES TO ON                           | E-SIXTH PREVIOUS AMOUNT.   |
| 64. REFERENCES                                     |  |
|  | B TO TEST NEW WEATHER SENSORS, IN  |
|  | TECHNOLOGY, MAY 6, 1968, PP. 71-69.***2)   |
| ·  | RELEASE NO. 68-48K, MAY 1968.***3)0S-  |
|  | N: A REVIEW OF A DECADE OF SPACE CAMERA METEOROLOGY, PRESENTED AT SOCIETY OF   |
|  | ATION ENGINEERS, WASH. D.C., AUG 1968.   |
| 65. HISTORICAL REMARKS                             | ATTON ENGINEERS, WASH. D.C., AUG 1900.   |
|  | FLOWN DN ATS 3. SCHEDULED FOR NIMBUS D.  |
| NETERCES AVOS FEOS ATTE                            | TEGRIN DA ATS SO SCHOOLED FOR WINDOS DO  |
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|                                      |                   | 4      | GREENBELT, MD. 2   | 0771    |                   |       |                    |            |          |                 |
|--------------------------------------|-------------------|--------|--------------------|---------|-------------------|-------|--------------------|------------|----------|-----------------|
| 1. TITLE                             |                   |        |                    |         |                   |       | 2. /               | ACRONYM    | 3. E     | XP NO           |
| IMAGE-DIS                            | SECTOR CAMER      | A SY   | STEM               |         |                   |       | II                 | C S        |          |                 |
| (TITLE CONT.                         |                   |        |                    |         |                   |       |                    | ESUME DATE |          | 5.<br>VERSION   |
|                                      |                   |        |                    |         |                   |       | ]09                | 701/       | 72       | 0007            |
| 6. PRINCIPAL IN                      | IVESTIGATOR       | 7. OR  | GANIZATION         |         | 8. TELEPHONE      |       |                    |            |          |                 |
| BRANCHFLOWER, G. GODDARD SPACE FLT C |                   |        |                    | T CE    | ENTER             | 301   | L <b>-</b> 982     | -504       | 2        |                 |
| 9. CO-INVESTIGATOR 10.               |                   |        | GANIZATION         |         | •                 | 11. T | ELEPHO             | NE         |          | ~~~             |
|                                      |                   |        |                    |         |                   |       |                    |            |          |                 |
| 12. CONTRACT<br>TYPE                 | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | MBER    | 15. START<br>DATE | 16. C | OMPLETION<br>DATE  | 17. STA    | TUS      |                 |
|                                      | NAS 5-9619        |        |                    |         |                   |       |                    | OPER       | ATI      | ONAL            |
| 18. MONITOR                          |                   | 19. AG | ENCY               | 20. PGM | OFFICE            | 21. T | ELEPH              | ONE        |          |                 |
| SCHARDT,                             | B.B.              | NASA   | A HDQTPS           | OA/E    | ERN               | 202   | 2 <del>-</del> 755 | -232       | 2        |                 |
| 22. VENDOR                           |                   |        | 23. LOCATION       |         |                   |       | 24. FLIGH<br>DATE  | 7 25. L    | EAD.     | TIME            |
| ITT INDUS                            | STRIAL LABS.      |        | FORT WAYNE,        | IND     | IANA              |       | 04/7               | 70 NA      |          |                 |
| 26. INSTRUMEN                        | T TYPE            |        |                    |         |                   |       |                    |            |          | 27.<br>SECURITY |
| IMAGER,                              | -INCH ELECTR      | RICAL  | LY-SCANNING        | PHO     | TOCATE            | HODE  | EVIS               | SIBLE      |          | UNC             |
| 28. APPLICATIO                       |                   |        |                    |         | 9. SPACE          |       |                    |            |          |                 |
| MET                                  |                   |        |                    | . [     | NI MBUS           | 5-4   |                    |            |          |                 |
| 30. PURPOSE                          |                   |        |                    |         |                   |       |                    |            |          |                 |
| D D T M AD V _ 1                     | TO ACOUTER HI     | CH-    | PESCILITION PI     | CTU     | RES OF            | = TI  | HF F/              | ARTH!      | <u>s</u> |                 |

PRIMARY-TO ACQUIRE HIGH-RESOLUTION PICTURES OF THE EARTH'S DAYTIME CLOUD COVER.

## 31. PRINCIPLES OF OPERATION

THE IMAGE DISECTOR CAMERA PERFORMS THE FUNCTIONS THAT PREVIOUS-LY REQUIRED BOTH AN AVCS AND AN APT. IT HAS ALSO FLOWN ON ATS 3. BUT WITH DIFFERENT OPTICS. AND IS CURRENTLY FLYING ON NIMBUS 3. A SCENE IS OPTICALLY FOCUSED ON THE PHOTOCATHODE AND PHOTOELEC-TRONS ARE EMITTED FROM THE SURFACE IN PROPORTION TO THE INCIDENT ILLUMINATION. THE PHOTOELECTRONS ARE ACCELERATED TOWARD AND FOCUSED ON A PLANE WHICH CONTAINS A PINHOLE APERTURE AT ITS CEN-THE ELECTRON IMAGE IS DEFLECTED PAST THE APERTURE BY MEANS TER. THE APERTURE SAMPLES THE ELECTRON IMAGE OF MAGNETIC DEFLECTION. AND A SECONDARY-EMISSION ELECTRON-MULTIPLIER SECTION AMPLIFIES THE CAMERA IS USED IN THE LINE THE SIGNAL BY ABOUT 10 MILLION. SCAN MODE WITH THE SPACECRAFT MOTION ALONG THE ORBITAL TRACK PROVIDING THE OTHER SCAN COMPONENT. NO SHUTTER IS REQUIRED AS THE SENSOR IS A NON-STORAGE TYPE, AND EXPOSURE TO THE SCENE IS THE VERY NARROW BANDWIDTH (1800 HZ) RESULTS IN GEN-CONTINUOUS. ERATION OF A VIDEO SIGNAL WITH THE HIGH NOMINAL S/N OF 40 DB. THE CAMERA-LINE FREQUENCY IS 4 HZ WITH THE FRAME PERIOD BEING 200 SEC. THE LENS APERTURE IS FIXED AT F/3. THE GROUND RESOLU-TION IS 1.7 NM AT THE SUBSATELLITE POINT. REALTIME PICTURES CAN BE TRANSMITTED TO APT RECEIVING STATIONS.

## 32. PHENOMENA OBSERVED

LIGHT REFLECTED FROM THE EARTH'S SURFACE AND CLOUD COVER.

33. MEASUREMENT RANGE

100 TO 10,000 FOOT-LAMBERTS

34. PRECISION AND ACCURACY

800 TV LINE RESOLUTION, S/N=40 DB AT 10,000 FOOT-LAMBERTS

| 35. SPECTRAL RANGE   | ,                            | ,  | 36. SPECTRAL   | RESOLUTION   | 37. TIME CONSTANT  |
|--|------------------------------|--|--|--|--|
| 0.4 T  | 0 0.7                        | MICRONS  | NA   |  | 200. SECONDS   |
| 38. FIELD OF VIEW  |                              | 39. GROUND SW  |  |  |  |
| 98.2 BY  | 73.6 DEG                     | 1400 NM B  | Y 900 NM   | FROM 600   | NM ALTITUDE  |
| 40. ANGULAR RESOLUTION   |                              |  |  |  |  |
| 0.16 DEG   | 1.7 NM AT                    | CENTER FR  | OM 600 N   |  |  |
| 42. POINTING ACCURACY 4  | 13. POINTING RATE            |  | ITUDE  | 45. INCLINA  |  |
|  |                              | MED  | CIRCULA  | R SUN-SY   | NCH RETROGRADE   |
| 46. SPECIAL REQUIRE  |                              | SORC WICK  | SE LEIK  | TO VENV C  | WALL VALUES  |
| SPACECRAFT A   | IIIIUUE EKI                  | KUKS MUSI  | BE HELD  | IU VERT 3  | MALL VALUES  |
| 47. COMPONENTS   | TOD CCANIAL                  | TAIC ADEDTI  | DE. 12 C   | TACE ELEC  | TRON MULTIPLIER  |
| 48. WEIGHT 49. VO  |                              |  |  | POWER 52. PEA  |  |
| 14 LB  | 0.2 CU F                     | to the second se | Control of the Contro | ATT  | Construction of the second sec |
|  |                              |  |  | 58. SHIELDING  |  |
| The second secon | NSITIVE                      | NFENERGE   |  |  |  |
| 59. CALIBRATION  |                              | 60. DATA RE  | COVERY   | 61. FRE  | QUENCY OF OBSERVATION  |
| 4.174  | - 80                         | DELAYED  | AND REA  | LTIME 14   | PICTURES/ORBIT   |
| 62. TELEMETRY REQU   | IREMENTS                     |  |  |  |  |
| 1 VIDEO CHAN   | NEL (1800 1                  | HZ BANDWID   | TH), 12  | HOUSEKEEP  | ING CHANNELS   |
|  |                              |  |  |  |  |
|  |                              |  |  |  |  |
| 63. ADVANTAGES AN  |                              |  | e de la companya de l | e de la companya della companya della companya de la companya dell |  |
| HAS APT CAPA   | BILITY; DAY                  | YLIGHT USE   | DNLY.  |  |  |
|  |                              |  |  | · · · · · · · · · · · · · · · · · · ·  |  |
| 64. REFERENCES   | عربين الشفرين والمسخاف أوالم | and the second s |  |  | ·  |
| 1) FRANKLIN,   | •                            |  |  |  |  |
| I  |                              |  |  |  | ROLOGY INSTRU-   |
| MENTS. NASA  | PERC REPUR                   | NU. PM-6   | (15, JUN   | E 1961.  |  |
|  |                              |  |  |  |  |
|  |                              |  |  |  |  |
| 65. HISTORICAL REMA  | ARKS                         |  | 4  | 184.2  |  |
| REPLACES AVC   | OTO STATE                    | . FLOWN D  | N ATS 3  | AND VIMBU  |  |
| METEROES ATS   | <u> </u>                     | ,  | <u>,, ,, , , , , , , , , , , , , , , , , </u>  | ,,,, <u>,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,</u>  |  |
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|--|-------------------|--------|---------------------------------------|---------|-------------------|--------------|---------------------------------------|------------|-------------|-----------------|
| 1. TITLE                               |                   |        |                                       |         |                   |              | 2. 4                                  | ACRONYM    | 3. EX       | P NO            |
| MULTISPE                               | CTRAL PHOTOG      | RAPH   | IC FACILITY:                          | EAR     | TH                |              | MI                                    | PF         | S-1         | 90              |
| (TITLE CONT.                           |                   |        |                                       |         |                   |              | 4. R                                  | ESUME DATE |             | ERSION          |
| RESOURCE                               | S EXPERIMENT      | PAC    | KAGE (EREP)                           |         |                   |              | 0.0                                   | 9/017      | 72          | 004             |
| 6. PRINCIPAL IN                        |                   | 7. OR  | GANIZATION 8. TELEPHONE               |         |                   |              |                                       |            |             |                 |
| DORNBACH, J. E. MANNED SPACECRAFT CENT |                   |        | ENTER                                 | 71      | <b>3-4</b> 8:     | 3-012        | 3                                     |            |             |                 |
|  |                   |        |                                       |         |                   |              | ELEPHO                                | NE         |             |                 |
|  |                   |        |                                       |         |                   |              |                                       |            |             |                 |
| 12. CONTRACT<br>TYPE                   | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU                    | MBER    | 15. START<br>DATE | 16. C        | OMPLETION<br>DATE                     | 17. STA    | rus         |                 |
|  |                   |        |                                       |         |                   |              |                                       | ENG.       | MODE        | EL              |
| 18. MONITOR                            |                   | 19. AG | ENCY                                  | 20. PGA | N OFFICE          | 21. T        | ELEPHO                                | ONE        |             |                 |
| FISHCHET                               | TI, T.L.          | NAS    | A HDQTRS                              | 04/     | 'ERS              | 202-755-2322 |                                       |            |             |                 |
| 22. VENDOR                             |                   |        | 23. LOCATION                          |         |                   |              | 24. FLIGHT                            | 25. L      | EAD 1       | IME             |
| ITEK COR                               | PORATION          | -      |                                       |         |                   |              | 19                                    | 73         |             |                 |
| 26. INSTRUMEN                          |                   |        |                                       |         |                   |              |                                       |            |             | 27.<br>SECURITY |
| CAMERA                                 |                   |        |                                       |         |                   |              |                                       |            |             | UNC             |
| 28. APPLICATIO                         | N .               |        |                                       |         | 29. SPACE         | CRAF         | Т                                     |            |             |                 |
| ERSP                                   |                   |        |                                       |         | SKYLA             | B-A          |                                       |            |             |                 |
| 30 PURPOSE                             |                   |        |                                       |         |                   | ****         | · · · · · · · · · · · · · · · · · · · |            | <del></del> |                 |

PRIMARY-TO OBTAIN PRECISION MULTISPECTRAL PHOTOGRAPHY WHICH WILL PROVIDE THE BASIS FOR A WIDE RANGE OF USER-ORIENTED STUDIES\*\*\* SECONDARY-TO EXTEND THE CAPABILITY FOR MULTISPECTRAL PHOTOGRAPH-IC STUDY SIGNIFICANTLY BEYOND THAT REPRESNTED BY EXPERIMENT SO-65 (FOUR 70-MM CAMERAS APOLLO-9 EXPERIMENT).

#### 31. PRINCIPLES OF OPERATION

THE FACILITY WILL UTILIZE SIX HIGH PRECISION 70MM CAMERAS WITH MATCHED DISTORTION AND FOCAL LENGTH. THE LENSES WILL HAVE A 6-INCH FOCAL LENGTH (21.2DEG FOV ACROSS FLATS) PROVIDING APPROXI-MATELY 88NM SQUARE SURFACE COVERAGE FROM THE EXPECTED 235 NM OR-THE SYSTEM WILL BE DESIGNED FOR THE FOLLOWING WAVELENGTH! FILM COMBINATION: .5-.6MM-PAN X BEW, .6-.7MM-PAN X BEW, .7-.8MM-IR B&W, .8-.9MM-IR B&W, .5-.88MM-IR COLOR, .4-.7MM-HI-RES COLOR. VARIOUS FILM/FILTER COMBINATIONS WILL BE STUDIED. THE SPECTRAL REGIONS DESIGNATED WERE SELECTED TO SEPERATE THE VISIBLE AND PHOTOGRAPHIC INFRARED SPECTRUM INTO THE BANDS THAT ARE EXPECTED TO BE MOST USEFUL FOR MULTISPECTRAL ANALYSIS. THE SELECTION WAS BASED ON EXPERIENCE GAINED IN THE PERFORMANCE OF EXPERIMENT SO65. THE TWO COLOR FILMS WILL PROVIDE A PREREGISTERED CROSS-CHECK OF THE BLACK AND WHITE IMAGERY IN TWO PROVEN COLOR COMBIN-ATIONS. PRIOR TO EACH PHOTO PASS, THE SKYLAB CREW WILL RECEIVE A CROUND UPDATE FOR EACH PHOTO SEQUENCE CONSISTING OF THE TIME FOR THE FIRST EXPOSURE, THE INTERVALOMETER SETTING, EXPOSURE SETTING. AND NUMBER OF EXPOSURES.

## 32. PHENOMENA OBSERVED

REFLECTED RADIATION FROM EARTH

33. MEASUREMENT RANGE

WAVELENGTHS 0.4 TO 0.9 MICRONS.

34. PRECISION AND ACCURACY

FILTER CALIBRATIONS, PRE AND POST FLIGHT.

| 35. SPECTRAL RANGE                    | 36. SPECTRAL RESOLUTION 37. TIME CONSTANT                   |
|---------------------------------------|---|
| 0.4 10 0.4                            |   |
| 38. FIELD OF VIEW                     | 39. GROUND SWATH  |
|                                       | EQ 88 NM FROM 235 NM ORBIT.                                 |
| 40. ANGULAR RESOLUTION 41. SPATIAL RE |   |
| 0.004 DEG 100 FT I                    | FROM 235 NM ORBIT.  |
| 42. POINTING ACCURACY 43. POINTING RA |   |
| +-2 DEQ                               | MED-CIRCULAR 50 DEG   |
| 46. SPECIAL REQUIREMENTS              |   |
| MANUAL OPERATION                      |   |
| 47. COMPONENTS                        |   |
| SEE ITEM 31                           |   |
| 48. WEIGHT 49. VOLUME                 | 50. AVERAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF |
| 328 LB 18.9 CU                        | FT 616 WATTS  |
| 54. INTERFERENCE 55. MAGNETIC 56.     | NUCLEAR NTERFERENCE 57. INTERFERENCE 58. SHIELDING          |
| NONE NONE S                           | SENSITIVE SENSITIVE FILM STORED IN VAULT.                   |
| 59. CALIBRATION                       | 60. DATA RECOVERY 61. FREQUENCY OF OBSERVATION              |
| PRE-FLT CHECK-OUT                     | FILM RECOVERY FLEXIBLE                                      |
| 62. TELEMETRY REQUIREMENTS            |   |
| NA                                    | ,                     |
|                                       |   |
|                                       | i   |
| 63. ADVANTAGES AND LIMITATIONS        |   |
| HIGH RESOLUTION MULTI                 | SPECTRAL PHOTOGRAPHY IN BANDS SIMILAR TO                    |
| ERTS-A SENSORS.                       | STECTIME THOUSONALITY IN DANIES STRIEGE TO                  |
| 64. REFERENCES                        |   |
|                                       | TION PLAN FOR MANNED SPACE FLIGHT EXPERI-                   |
|                                       | HULTISPECTRAL PHOTOGRAPHIC FACILITY                         |
| (EARTH APPLICATIONS).                 |   |
|                                       | TTE SENSING SYSTEMS, MSC-P6-0406                            |
| EARTH RESUURCES REMU                  | 11E 2EN2TING 2121EM2 + W2C-62-0400                          |
|                                       |   |
| 65. HISTORICAL REMARKS                |   |
| 05. HISTORICAL REWARKS                |   |
|                                       |   |
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|----------------------|-------------------|------------------------|--------------------|--------|-------------------|--------------|--------------------|------------|---------|-----------------|
| 1. TITLE             |                   |                        |                    |        |                   |              | 2. A               | CRONYM     | 3. E)   | KP NO           |
| MULTISPE             | CTRAL TERRAIN     | V-PH                   | DTOGRAPHY EXP      | PERI   | MENT              |              | MT                 | ρ          | S06     | 5               |
| (TITLE CONT.         |                   |                        |                    |        |                   |              | 4. RI              | ESUME DATE | 5.<br>V | ERSION          |
|                      |                   |                        |                    |        |                   |              | 6.9                | 7/01/      | 72      | 0004            |
| .6. PRINCIPAL IN     | NVESTIGATOR       | 7. OR                  | GANIZATION         |        |                   | 8. TELEPHONE |                    |            |         |                 |
| LOWMAN, I            | DR. P.D.          | GODI                   | DARD SPACE FL      | T C    | ENTER             | 301-982-5042 |                    |            |         |                 |
| 9. CO-INVESTIG       | ATOR              |                        |                    |        |                   | 11. T        | ELEPHO             | NE         |         |                 |
| COLWELL,             | DR. P.D.          | UNIV OF CALIF. BERKLEY |                    |        |                   | 415-845-6000 |                    |            |         |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER                     | 14. FLASH INDEX NU | MBER   | 15. START<br>DATE | 16. C        | OMPLETION<br>DATE  | 17. STA1   | rus     |                 |
|                      |                   |                        |                    |        |                   |              |                    | POST       | FL      | [GHT            |
| 18. MONITOR          |                   | 19. AG                 | ENCY               | 20. PG | M OFFICE          | 21. T        | ELEPHO             | ONE        |         |                 |
| TERWILLI             | GER, R.G.         | NAS                    | A HDQTRS           | OA     | 'ERO              | 20:          | 2-755              | -2322      | 2       |                 |
| 22. VENDOR           |                   |                        | 23. LOCATION       |        |                   |              | 24. FLIGHT<br>DATE | 25. L      | EAD 1   | LIME            |
| MSC INHOU            | JSE (HASSELBI     | AD)                    | HOUSTON, TEX       | KAS    |                   |              | 03/6               | 9 NA       |         |                 |
| 26. INSTRUMEN        | T TYPE            |                        |                    |        |                   |              |                    |            |         | 27.<br>SECURITY |
| IMAGER,              | FOUR 70-MM MO     | DEL                    | 500-EL HASSE       | ELBL   | AD CAL            | MER          | A.S                |            |         | UNC             |
| 28. APPLICATIO       | N .               |                        |                    |        | 29. SPACE         | CRAF         | T                  |            |         |                 |
| ERSP                 |                   |                        |                    |        | APOLL             | 0 9          |                    |            |         |                 |
| 30. PURPOSE          |                   |                        |                    |        |                   |              |                    |            |         |                 |

PRIMARY-TO OBTAIN PHOTOGRAPHS, TAKEN SIMULTANEOUSLY, IN FOUR SPECIFIC PORTIONS OF THE VISIBLE AND NEAR (PHOTOGRAPHIC) INFRA-RED FOR EARTH RESOURCES APPLICATIONS.\*\*\*SECONDARY-TO ASSIST IN DETERMINING THE OPTIMUM FILM-FILTER COMBINATIONS FOR THE EARTH RESOURCES PROGRAM.

## 31. PRINCIPLES OF OPERATION

THE EQUIPMENT USED CONSISTS OF FOUR HASSELBLAD, 70 MM CAMERAS, MODEL 500-EL. THE INDIVIDUAL CAMERAS ARE SIMILAR TO THE 500 C USED ON PREVIOUS MANNED MISSIONS, EXCEPT THAT THIS SET IS ELEC-TRICALLY DRIVEN. THE CAMERAS ARE INSTALLED IN A COMMON MOUNT AND SYNCHRONIZED FOR SIMULTANEOUS EXPOSURE. THE MOUNT IS IN-STALLED IN THE CUMMAND MODULE HATCH WINDOW DURING PHOTOGRAPHIC OPERATIONS AND THE SPACECRAFT WILL BE ORIENTED TO PROVIDE VERTI-CAL PHOTOGRAPHY. AN INTERVALOMETER IS USED TO OBTAIN SYSTEMATIC OVERLAPPING (STEREO) PHOTOGRAPHY. POWER IS SUPPLIED BY INTERNAL EACH CAMERA HAS A STANDARD 80 MM FOCAL LENGTH, BATTERIES. PLANAR LENS AND A SINGLE FILM MAGAZINE CONTAINING FROM 160 TO 200 FRAMES. THE FOLLOWING FILM/FILTER COMBINATIONS WERE USED: 1) INFRARED AEROGRAPHIC FILM WITH AN 89B FILTER, 0.7 TO 0.9 MICRON; 2) COLOR IR WITH A WRATTEN 15 FILTER, 0.7 TO 0.9 MICRON; 3) PANATOMIC-X WITH.A 25A FILTER, 0.58 MICRON INTO THE IR RE-GION; AND 4) PANATOMIC-X WITH A 58 FILTER, 0.48 TO 0.62 MICRON; PHOTOGRAPIC COVERAGE OF THE SOUTHWEST U.S.A. WAS EMPHASIZED BECAUSE GROUND INFORMATION IS MORE AVAILABLE FOR THIS REGION THAN OTHER REGIONS.

#### 32. PHENOMENA OBSERVED

REFLECTED SOLAR RADIATION FROM THE SURFACE OF THE EARTH

## 33. MEASUREMENT RANGE

VARIES WITH TYPE OF FILM USED

34. PRECISION AND ACCURACY

| 35. SPECTRAL RANGE                     |                 | 36. SPECTRAL RESOL  | UTION 37. TIME CONSTANT      |
|--|-----------------|---|------------------------------|
| 0.48 TO 0.9                            | MICRON          |   |                              |
| 38. FIELD OF VIEW                      | 39. GROUND SWA  |   |                              |
|  |                 | 300 NM FROM   | 300 NM ALTITUDE              |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES |                 |   |                              |
| 0.009 DEG 280 FEET                     |                 |   |                              |
| 42. POINTING ACCURACY 43. POINTING RAT |                 |   | INCLINATION                  |
| 5.0 DEG                                | <u> LDW</u>     | CIRCULAR   ME   | DIUM POSIGRADE               |
| 46. SPECIAL REQUIREMENTS               | IC DECIDED      | AT THE TIME   | OF CACH EXPOSINE             |
| ORBITAL POSITION DATA  47. COMPONENTS  | 13 DESIKED      | AT THE TIME   | OF EACH EXPUSURE             |
| 4 HASSELBLAD CAMERAS                   |                 |   |                              |
| 48. WEIGHT 49. VOLUME                  | 50. AVERAGE POW | R 51. STANDBY POWER   | 52. PEAK POWER 53. MTBF      |
| 28 LB 1.5 CU F                         | T               | A Marie S. A. C. C. C. C. C. C. C. C. C. C. C. C. C.  |                              |
|  |                 | HERMAL<br>REFERENCE 58. SHIE  | LDING                        |
| NONE NONE NO                           | NE SE           | VSITIVE   |                              |
| 59. CALIBRATION                        | 60. DATA REC    |   | 61. FREQUENCY OF OBSERVATION |
| PRE- AND POSTFLIGHT ON                 | LYMANNED        | RETURN  | AS PROGRAMMED                |
| 62. TELEMETRY REQUIREMENTS             | 4/2011          |   |                              |
| NO SPECIFIC REQUIREMEN                 | TS              |   |                              |
|  |                 |   |                              |
| AN ADMANTA OF CAMP A MARKET COMP       |                 |   |                              |
| 63. ADVANTAGES AND LIMITATIONS         |                 |   |                              |
| NO GROUND SUPPORT REQU                 | IRED, CAME      | RAS HAVE BEEN   | I FLIGHT QUALIFIED           |
| 64. REFERENCES                         |                 | ALCONOMICS OF THE PARTY OF THE |                              |
| 1) EXPERIMENT IMPLEMENT                | ATTON DIAM      | EDD MIN TICOS   | CTOAL TERRATAL               |
| PHOTOGRAPHY (SO65). NA                 |                 |   |                              |
| NO:69-29, APOLLO 9. FE                 |                 |   |                              |
| IMAGERS FOR THE SMALL                  |                 |   |                              |
| INSTITUTE, APRIL 1967.                 | CANTIT NESS     | JACES SAFEELI   | TE TIT RESEARCH              |
|  |                 |   |                              |
| 65. HISTORICAL REMARKS                 |                 |   | . 1                          |
| SIMILAR CAMERAS FLOWN                  | ON OTHER M      | ANNED FLIGHTS   |                              |
|  |                 |   |                              |
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|-------------------------------------|-------------------|--------|---------------------|---------|-------------------|--------------|-------------------|---------------|-----|-----------------|
| 1. TITLE                            |                   |        |                     |         |                   |              | 2.4               | ACRONYM       | 3.  | EXP NO          |
| RETURN B                            | EAM VIDICON       | CAME   | R A                 |         |                   |              | RI                | 3VC           |     |                 |
| (TITLE CONT.                        |                   |        |                     |         |                   |              | 4. R              | ESUME DATE    |     | 5.<br>VERSION   |
| ,                                   |                   |        |                     |         |                   |              | 0                 | 9/01/         | 72  | 2007            |
| 6. PRINCIPAL IN                     | VVESTIGATOR       | 7. OR  | GANIZATION          |         |                   | 8. TE        | LEPHO             | NE            |     |                 |
| WEINSTEI                            | N, O.             | GOD    | DARD SPACE FL       | T C     | ENTER             | 301-982-5042 |                   |               |     |                 |
| 9. CO-INVESTIGATOR 10. ORGANIZATION |                   |        |                     | 11. TI  | ELEPHO            | NE           |                   |               |     |                 |
| RAGLANO.                            | Τ,                | GOD    | DARD SPACE FL       | TC      | ENTER             |              |                   | 2-504         |     |                 |
| 12. CONTRACT<br>TYPE                | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NUI | ABER    | 15. START<br>DATE | 16. CC       | DATE              | 17. STAT      | US  |                 |
| CPIF                                | NAS5-11621        |        |                     |         | 10/6              | 8 0          | 2/70              | OPER          | AΤ  | IONAL           |
| 18. MONITOR                         |                   | 19. AG | ENCY                | 20. PGM | OFFICE            | 21. T        | ELEPH             | ONE           |     |                 |
| GEORGE.                             | Ι                 | NAS    | A HDQTRS            | DA/     | ER                | 20           | 2 <del>-</del> 75 | 5 <b>-232</b> | 2   |                 |
| 22. VENDOR                          | r                 |        | 23. LOCATION        |         |                   |              | 24. FLIGHT        | 25. L         | EAI | TIME            |
| RCA ASTR                            | O-ELECTRONIC      | S      | PRINCETON, N        | ۱.J.    |                   |              | 7/                | 72 NA         |     |                 |
| 26. INSTRUMEN                       | T TYPE            |        |                     |         |                   |              |                   |               |     | 27.<br>SECURITY |
| IMAGER.                             | 2-INCH HIGH-      | RESO   | LUTION RETURN       | N-BE    | AM-VI             | DIC          | ON                |               |     | UNC             |
| 28. APPLICATIO                      |                   |        |                     |         | 9. SPACE          |              |                   |               |     |                 |
| ERSP, ME                            | T                 |        |                     |         | ERTS              | -18          | В                 |               |     |                 |
| 30 PURPOSE                          |                   |        |                     |         |                   |              |                   |               |     |                 |

PRIMARY-TO PROVIDE CONTINUOUS, OVERLAPPING MULTI-SPECTRAL PHOTO-GRAPHIC COVERAGE OF THE EARTH'S SURFACE ALONG THE ORBITAL TRACK AND REPEATED OBSERVATIONS OF ANY GIVEN AREA WITHIN THE MINIMUM TIME INTERVAL POSSIBLE.

## 31. PRINCIPLES OF OPERATION

THE RBVC, AS PROPOSED, IS A 3 CAMERA SYSTEM SPANNING THE VISIBLE SPECTRUM IN 3 BANDS: .475-.575, .580-.680, AND .690-.830 MICRON. SPECTRAL BANDS ARE OBTAINED THROUGH USE OF FILTERS IN ACQUISI-TION OPTICS. AN ELECTRONICALLY TRIGGERED, VARIABLE-SPEED, FOCAL-PLANE SHUTTER ALLOWS PICTURE-TAKING OVER A WIDE RANGE OF SCENE BRIGHTNESS AND PROVIDES UNIFORM EXPOSURE OF THE VIDICON. SENSOR. A 2-INCH RETURN BEAM VIDICON, COMBINES THE VIDICON AND ORTHICON TUBE. THE VIDEO OUTPUT IS DERIVED FROM THE RETURN SCAN-A PHOTOCONDUCTIVE SURFACE CHARGES THE TARGET SURFACE NING BEAM. IN PROPORTION TO THE LIGHT RECEIVED. THEN AS THE ELECTRON SCAN-NING BEAM TRAVERSES THE TARGET, THE CHARGE MODULATES THIS BEAM WHICH IS THEN AMPLIFIED BY AN ELECTRON MULTIPLIER. THE VIDEO OUTPUT OF THE SYSTEM MAY BE FED DIRECTLY TO THE MODULATOR OF THE SPACECRAFT COMMUNICATION SYSTEM. THE CAMERAS ARE POINTED AT NADIR AND A NEW SCENE IS IMAGED ON THE PHOTO CONDUCTOR SURFACES EVERY 25 SEC. THE NOMINAL RESOLUTION CAPABILITY OF THE SYSTEM IS 3200 TV LINES. EQUIPPED WITH A 126 MM F.L., T/3.2 LENS, EACH FRAME WILL COVER AN AREA OF 100 X 100 NM AT A RESOLUTION OF ABOUT 200 FEET PER TV LINE FROM 496 NM ALTITUDE. THE SENSOR IS <u>CAPABLE OF RESOLVING ABOUT 60 LINE-PAIRS/MM AT A TOC OF 2:1</u> 22. PHENOMÉNA OBSERVED

RADIATION FROM THE SURFACE OF THE EARTH IN THE VISIBLE SPECTRUM.

DYNAMIC RANGE=9 GRAY LEVELS: BANDS 162, 7 GRAY LEVELS: BAND 3

S/N=33 DB AT 0.8 JOULE /SQ-CM: BANDS 182, 25 DB AT 1.2: BAND 3

| 35. SPECTRAL RANGE              |                             | 36. SPECTRA                 | L RESOLUTION    | 37. TIME CONSTANT     |
|---------------------------------|-----------------------------|-----------------------------|-----------------|-----------------------|
| 0.475 TO                        | C.830 MICRON                | NA                          |                 |                       |
| 38. FIELD OF VIEW               | 39. GROUN                   |                             |                 |                       |
| 11.5 BY 11.                     | 5 DEG 100 NM                | BY 100 NM                   | FROM 496        | NM ALTITUDE           |
| 40. ANGULAR RESOLUTION 41. SPA  |                             |                             |                 |                       |
|                                 | FEET PER TV                 |                             |                 |                       |
| 42. POINTING ACCURACY 43. POINT |                             | I. ALTITUDE                 | 45. INCLINA     |                       |
| 45.0050141.05014051451450       |                             | ED C IRCULA                 | 1K   30 N = 3 T | NUT REINDORAUL        |
| 46. SPECIAL REQUIREMENTS        |                             |                             |                 |                       |
| 47. COMPONENTS                  |                             |                             |                 |                       |
| 3 REV CAMERAS (CA               | MERA HEAD +                 | ELECTRONIC                  | S), PECORD      | ER, TRANSMITTER       |
| 48. WEIGHT 49. VOLUME           |                             | GE POWER 51. STAND          |                 |                       |
| 175 LB 3.0                      | CU FT 144                   | WATTS 76 1                  | WATTS 168       | WATTS 12 MON          |
| 54. INTERFERENCE 55. MAGNETIC   | 56. NUCLEAR<br>INTERFERENCE | 57. THERMAL<br>INTERFERENCE | 58. SHIELDING   |                       |
| SENSITI                         | VF                          |                             |                 | SHIELDING USED        |
| 59. CALIBRATION                 |                             | A RECOVERY                  |                 | QUENCY OF OBSERVATION |
| IN-FLIGHT CALIBR                |                             | YED TELEME                  | IKA TON         | COMMAND               |
| 62. TELEMETRY REQUIREMEN        | · -                         | AVEDACE OF                  | - 14 300 TT     | C DED DAY             |
| 20 MINUTES PER OR               | RII RAZED AN                | AVEKAGE UI                  | F 14 JKB11      | S PER DAY             |
| 63. ADVANTAGES AND LIMITA       |                             |                             |                 |                       |
| HIGH RESOLUTION M               |                             | L PHOTOGRAI                 | PHY WITH 1      | YEAR OPERA-           |
| TIONAL CAPABILITY               | •                           |                             |                 |                       |
| 1) RCA ASTRU-ELECT              | DONICS DIV                  | TECHNICAL I                 | CDODIC. 1       | 068                   |
| I TACA ASTAG ELECT              | NOTICS DIVI                 | , ECIMICAL                  | · E · Civi Oy L | 200                   |
|                                 |                             |                             |                 |                       |
|                                 |                             | -                           |                 |                       |
|                                 |                             | ·                           |                 |                       |
|                                 |                             | •                           |                 |                       |
|                                 |                             | ·                           |                 |                       |
| 65. HISTORICAL REMARKS          |                             |                             |                 |                       |
| 65. HISTORICAL REMARKS          |                             |                             |                 |                       |
| 65. HISTORICAL REMARKS          | ·                           |                             |                 | ,                     |
| 65. HISTORICAL REMARKS          |                             |                             |                 |                       |
| 65. HISTORICAL REMARKS          |                             |                             |                 | ·                     |
| 65. HISTORICAL REMARKS          |                             |                             |                 |                       |
| 65. HISTORICAL REMARKS          |                             |                             |                 |                       |
| 65. HISTORICAL REMARKS          | ·                           |                             |                 |                       |
| 65. HISTORICAL REMARKS          |                             | ·                           |                 |                       |
| 65. HISTORICAL REMARKS          |                             |                             |                 |                       |
| 65. HISTORICAL REMARKS          |                             |                             |                 |                       |
| 65. HISTORICAL REMARKS          |                             |                             |                 |                       |
| 65. HISTORICAL REMARKS          |                             |                             |                 |                       |
| 65. HISTORICAL REMARKS          |                             |                             |                 |                       |
| 65. HISTORICAL REMARKS          |                             |                             |                 |                       |
| 65. HISTORICAL REMARKS          |                             |                             |                 |                       |
| 65. HISTORICAL REMARKS          |                             |                             |                 |                       |
| 65. HISTORICAL REMARKS          |                             |                             |                 |                       |
| 65. HISTORICAL REMARKS          |                             |                             |                 |                       |
| 65. HISTORICAL REMARKS          |                             |                             |                 |                       |

## NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771

|                      |                                  |                                    | G112C112221, 11121 2    |        |                   |                  |                           |            |                 |  |  |
|----------------------|----------------------------------|------------------------------------|-------------------------|--------|-------------------|------------------|---------------------------|------------|-----------------|--|--|
| 1. TITLE             |                                  |                                    |                         |        |                   |                  | 2. /                      | ACRONYM    | 3. EXP NO       |  |  |
| SPIN-SCA             | V CLOUD-COVE                     | CA                                 | MERA                    |        |                   |                  | SS                        | SCC        |                 |  |  |
| (TITLE CONT.         | )                                |                                    |                         |        |                   |                  | 4. R                      | ESUME DATE | 5.<br>VERSION   |  |  |
| MONOCHPO             | MATIC                            |                                    |                         |        |                   |                  | 0.0                       | 1/01/      | 72 0004         |  |  |
| 6. PRINCIPAL II      | VESTIGATOR                       | 7. OR                              | GANIZATION              |        |                   | 8. TELEPHONE     |                           |            |                 |  |  |
| SUOMI, D             | R. V.E.                          | יז אט                              | UNIVERSITY OF WISCONSIN |        |                   |                  | 608-262-5938              |            |                 |  |  |
| 9. CO-INVESTIG       | CO-INVESTIGATOR 10. ORGANIZATION |                                    |                         |        |                   | 11. T            | ELEPHO                    | NE         |                 |  |  |
|                      | DR. R.J.                         | UNIVERSITY OF WISCONSIN 608-262-59 |                         |        |                   |                  |                           |            |                 |  |  |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB                | ER                                 | 14. FLASH INDEX NUI     | MBER   | 15. START<br>DATE | 16. <sup>C</sup> | 16. COMPLETION 17. STATUS |            |                 |  |  |
|                      | NAS5-9677                        | ·                                  |                         |        |                   | 2/66 PERATIONAL  |                           |            |                 |  |  |
| 18. MONITOR          |                                  | 19. AG                             | ENCY                    | 20. PG | M OFFICE          | 21. TELEPHONE    |                           |            |                 |  |  |
| BURKE. J             | R.                               | NAS                                | A HDQTRS                | OA/    | 'ECS              | 20               | 2-755                     | 5-232      | 2               |  |  |
| 22. VENDOR           |                                  |                                    | 23. LOCATION            |        |                   |                  | 24. FLIGHT<br>DATE        | ¹ 25. L    | EAD TIME        |  |  |
| SANTA BA             | RBARA RES CTI                    | R                                  | GOLETA, CALI            | IFOR   | NIA               |                  | 12/6                      | 66 NA      |                 |  |  |
| 26. INSTRUMEN        | T TYPE                           |                                    |                         |        |                   |                  |                           |            | 27.<br>SECURITY |  |  |
| IMAGER.              | TELESCOPE-PHO                    | IMO TO                             | ULTIPLIER ONE           | E-CH   | IANNEL            | ٧I               | SIBLE                     |            | UNC             |  |  |
| 28. APPLICATIO       |                                  |                                    |                         |        | 29. SPACE         |                  |                           |            |                 |  |  |
| MET                  |                                  |                                    |                         |        | ATS 1             |                  |                           |            |                 |  |  |
| 30. PURPOSE          |                                  |                                    |                         |        |                   |                  |                           |            |                 |  |  |

PRIMARY-TO PROVIDE HIGH-RESOLUTION PICTURES OF THE WHOLE EARTH'S DISK BETWEEN 52 DEG N AND 52 DEG S ALTITUDE ON A CONTINUOUS BASIS TO PERMIT SURVEILLANCE OF SHORT DURATION WEATHER CHANGES.

## 31. PRINCIPLES OF OPERATION

THE ATS SPIN SCAN CAMERA UTILIZES A HIGH RESOLUTION CASSEGRAIN TELESCOPE HAVING A "PINHOLE" APERTURE FOLLOWED BY A PHOTO-MULTIPLIER TUBE. THE VIDEO RASTER IS GENERATED IN THE WEST-EAST DIRECTION BY THE SATELLITE SPIN, NOMINALLY 100 RPM, AND IN THE NORTH-SOUTH DIRECTION BY MECHANICAL TILTING OF THE TELESCOPE OPTICAL AXIS IN DISCRETE STEPS FROM +7.5 TO -7.5 DEG. THIS PRO-VIDES EARTH COVERAGE FROM 52 DEG No. TO 52 DEG No. LATITUDE AND FROM THE WEST LIMB TO THE EAST LIMB. THIS AREA IS COVERED BY 2000 HORIZONTAL (W TO E) TV LINES. THE TOTAL LINE SCAN PERIOD PER REVOLUTION IS 0.6 SEC. A TOTAL TIME OF 20 MIN IS REQUIRED TO SCAN 1 PICTURE AND 2 MIN TO RETPACE. A BACK-TO-BACK MODE IS ALSO POSSIBLE IN WHICH THE RETRACE IS AT THE SAME RATE AS THE FORWARD SCAN. THE SCAN MAY BE REVERSED AT ANY TIME ONLY IN THE BACK-TO-A PARABOLIC PRIMARY QUARTZ MIRROR WITH A 5-IN DIAM BACK MODE. AND A 10-INCH FL IS USED WITH A FLAT SECONDARY QUARTZ MIRROR TO PRODUCE AN IMAGE ON THE FACE OF AN APERTURE PLATE. THE .001-INCH DIAM APERTURE PROVIDES AN ANGULAR RESOLUTION OF 0.1 MILLIRADIAN. THE INSTANTANEOUS OPTICAL FOV IS 1.94 NM. THE SPACECRAFT SPIN AXIS IS NORMALLY ORIENTED PERPENDICULAR TO THE ORBIT PLANE OF THE S/C AND PARALLEL TO THE SPIN AXIS OF THE EARTH.

#### 32. PHENOMENA OBSERVED

SUNLIGHT REFLECTED FROM THE FARTH'S SURFACE AND/OR CLOUDS
33. MEASUREMENT RANGE

33. MEASUREMENT KANGE

DYNAMIC RANGE = 1000 FOR BRIGHTNESS RESOLUTION

34. PRECISION AND ACCURACY

| 35. SPECTRAL RANGE                              | 36. SPECTRAL RESOLUTION 37. TIME CONSTANT   |
|---|---|
| 0.475 TO 0.630 MICRONS                          |   |
| 38. FIELD OF VIEW 39. GROUND SW.                |   |
| 15.0 BY 18.0 DEG LIMB-TO-L                      | IMB (7500 NM) FROM GED-SYNCH ALT  |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION   |   |
| 0.007 DEG 2.5 NM AT CENTER                      |   |
| 42. POINTING ACCURACY 43. POINTING RATE 44. ALT |   |
|   | H CIRCULAR EQUATORIAL POSIGRADE   |
| OPERATES ONLY DURING DAYLIGHT; HI               | CHI V SENSITIVE TO SUFER DISTORT  |
| 47. COMPONENTS                                  | OUT SENSTINE IN SMEEN MISINKI   |
| 1-INCH PHOTOMULT TUBE, 5-INCH PA                | PAROLOTO, 2-INCH CLAT MIDDOD  |
| 48. WEIGHT 49. VOLUME 50. AVERAGE POW           | was a sale to the |
| 16 LB C.45 CU FT                                | 7 WATTS 24 WATTS 5 YRS  |
|   | THERMAL 58. SHIELDING   |
| SENSITIVE                                       | ENTEREDIL VO. GITTLEVIIIG   |
| 59. CALIBRATION 60. DATA RE                     | COVERY 61. FREQUENCY OF OBSERVATION   |
|   | E TELEMETRY EVERY 22 MINUTES  |
| 62. TELEMETRY REQUIREMENTS                      | ICATINI EC MINOTES  |
| 150 KHZ VIDEO BANDWIDTH                         |   |
|   |   |
|   |   |
| 63. ADVANTAGES AND LIMITATIONS                  |   |
| FULL EARTH DISK PHOTOGRAPHY. EA                 |   |
| COMPLETE STORM HISTORIES TO BE R                | ECORDED.  |
| 64. REFERENCES                                  |   |
| 1) MET DATA CATALOG FOR ATS, VOL                |   |
| E. AND PARENT, R.J.:PROPOSAL FOR                | A SPIN SCAN CAMERA SYSTEM FOR   |
| A SYNCHRONOUS SATELLITE.JULY 196                | 5.***310STROW,H. AND WEINSTEIN,   |
| O.: A REVIEW OF A DECADE OF SPAC                | E CAMERA SYSTEMS DEVELOPMENT FOR  |
| MET. PRESENTED AT SOC OF PHOTO-O                |   |
| SYMP. 23 AUG 68. ***4) FILM DATA A              | VAIL FROM NAT WEATHER RECORD CTR  |
| 65. HISTORICAL REMARKS                          |   |
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GREENBELT, MD. 20771

| 1. TITLE                            |                   |        |  |        |                   |        | 2. A               | CRONYM    | 3.       | EXP NO          |
|-------------------------------------|-------------------|--------|--|--------|-------------------|--------|--------------------|-----------|----------|-----------------|
| SPIN-SCA                            | N CLOUD-COVE      | R CA   | MERA   |        |                   |        | SS                 | CC        |          |                 |
| (TITLE CONT.                        |                   |        |  |        |                   |        | 4 RE               | SUME DATE |          | 5.<br>VERSION   |
| MULTICOL                            | OP .              |        |  |        |                   |        | 0.9                | /01/      | 72       | 2004            |
| 6. PRINCIPAL IN                     | NVESTIGATOR       | 7. OR  | GANIZATION   |        | 8. TELEPHONE      |        |                    |           |          |                 |
| SUOMI, D                            | R. V.E.           | UNI    | VERSITY OF W   | I SCC  | ONSIN             | 608    | 8-262              | -593      | 8        |                 |
| 9. CO-INVESTIGATOR 10. ORGANIZATION |                   |        |  |        |                   | 11. T  | ELEPHO             | NE        |          |                 |
| PARENT, DR. R. J. UNIVERSITY C      |                   |        | VERSITY OF W   | ISCO   | DNSIN             | 60     | 8-262              | -593      | 9        |                 |
| 12. CONTRACT<br>TYPE                | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NUI  | MBER   | 15. START<br>DATE | 16. CC | DMPLETION<br>DATE  | 17. STA1  | rus      |                 |
| ····                                |                   |        |  |        |                   | 1      | 1/67               | OPER      | ΔΤΙ      | ONAL            |
| 18. MONITOR                         |                   | 19. AG | ENCY   | 20. PG | M OFFICE          | 21. T  | ELEPHO             | NE        |          |                 |
| BURKE, J                            | .R.               | NAS    | A HDQTRS   | OA/    | /EĈS              | 20     | 2 <del>-</del> 755 | -232      | 2        |                 |
| 22. VENDOR                          |                   |        | 23. LOCATION   |        |                   |        | 24. FLIGHT<br>DATE | 25. L     | EAD TIME |                 |
| SANTA BA                            | RBARA RCS CTI     | R      | GOLETA, CAL  | LEGE   | RNIA              |        | 11/6               | 7 NA      |          |                 |
| 26. INSTRUMEN                       | T TYPE            |        | •  |        |                   |        |                    |           |          | 27.<br>SECURITY |
| IMAGER,                             | THREE 1-INCH      | PHO    | TOMULTIPLIER   | VIS    | SIBLE-            | COL    | ) R                |           |          |                 |
| 28. APPLICATIO                      | N                 |        |  |        | 29. SPACE         | CRAF   | Т                  |           |          |                 |
| MET                                 |                   |        |  |        | ATS 3             | -      |                    |           |          |                 |
| 30. PURPOSE                         |                   |        | The state of the s |        |                   |        |                    |           |          |                 |

PRIMARY- TO OBTAIN HIGH RESOLUTION COLOR PHOTOGRAPHS FROM SYNCH-RONOUS ALTITUDE SO THAT CLOUD DEVELOPMENT, CLOUD DISPLACEMENTS, AND IN THE TERMINATOR ZONE, CLOUD ALTITUDES, CAN BE DETERMINED FOR USE IN STUDIES OF TROPICAL CONVECTION.\*\*\*SECONDARY-DETERMINE HORIZONTAL EXTENT OF OCEAN CURRENTS: SCATTERING OF THE ATMOS-PHERE IN BROAD SPECTRAL BANDS; VIEW MID-LATITUDE STORMS.

#### 31. PRINCIPLES OF OPERATION

THE MULTI-COLOR SPIN SCAN CAMERA IS AN ADVANCEMENT OVER THE MONOCHROMATIC SPIN SCAN CAMERA ON ATS 1. VISIBLE LIGHT REFLECTED FROM THE EARTH IS GATHERED BY A 5-INCH DIAMETER F/3 DALL-KIRKHAM TELESCOPE AND FOCUSED ALTERNATELY ON A SET OF THREE 0.0015 INCH DIAMETER FIELD-DEFINING APERTURES. AN APERTURE PASSES EITHER RED, GREEN, OR BLUE DETERMINED BY A COMBINATION OF THE NATURAL CUTOFFS OF THE DIFFERNET DETECTOR PHOTOCATHODES, CORNING FILTER-GLASS DIVERGING LENSES AND INTERFERENCE FILTERS. THE SPINNING MOTION OF THE SPACECRAFT PROVIDES THE CAMERA SCAN PAPALLEL TO THE EQUATOR. THE CAMERA STEPS ONE INCREMENT IN LATITUDE FOLLOW-ING EACH SPACECRAFT REVOLUTION PROVIDING POLE-TO-POLE COVERAGE IN 2400 SCAN LINES. WITH A SPIN RATE OF 100 RPM. THE TIME TO COVER ONE FRAME IS 24 MINUTES. RETRACE TAKES 4 MINUTES. SCAN CAN ALSO BE OPERATED IN A BACK-TO-BACK MODE. OPERATION HERE IS IDENTICAL TO THE NORMAL MODE DURING NORTH-TO-SOUTH OPER-ATION BUT DURING RETRACE THE SOUTH-TO-NORTH STEP IS AT THE SAME RATE AS THE FORWARD TRACE AND USEFUL VIDEO IS PRODUCED. THE OUT-PUTS FROM THE THREE PHOTOTUBES ARE MULTIPLEXED AND TRANSMITTED TO EARTH OVER THE SHE WIDE-BAND LINK.

#### 32. PHENOMENA OBSERVED

INTENSITY OF EARTH'S SPECTRAL REFLECTION IN THE BLUE. GREEN. RED 33. MEASUREMENT RANGE

34. PRECISION AND ACCURACY

|   | AL RESOLUTION 37. TIME CONSTANT       |  |  |  |  |  |  |  |
|---|---------------------------------------|--|--|--|--|--|--|--|
| 0.390 TO 0.700 MICRON   |                                       |  |  |  |  |  |  |  |
| 38. FIELD OF VIEW 39. GROUND SWATH                              |                                       |  |  |  |  |  |  |  |
|   | DO NM) FROM GED-SYNCH ALT             |  |  |  |  |  |  |  |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION                   | <u> </u>                              |  |  |  |  |  |  |  |
| 0.006 DEG 2 NM AT CENTER  | 1                                     |  |  |  |  |  |  |  |
| 42. POINTING ACCURACY 43. POINTING RATE 44. ALTITUDE            | 45. INCLINATION                       |  |  |  |  |  |  |  |
|   | LAR EQUATORIAL POSIGRADE              |  |  |  |  |  |  |  |
| 46. SPECIAL REQUIREMENTS  |                                       |  |  |  |  |  |  |  |
| 47. COMPONENTS  |                                       |  |  |  |  |  |  |  |
| TELESCOPE, 3 PHOTOMULTIPLIER LIGHT DETECT                       | TORS.STEP DRIVE MECHANISM             |  |  |  |  |  |  |  |
|   | BY POWER 52. PEAK POWER 53. MTBF      |  |  |  |  |  |  |  |
| 23 LB 0.54 CU FT 10 WATTS                                       | 22 WATTS                              |  |  |  |  |  |  |  |
| S4. INTERFERENCE S5. MAGNETIC S6. INTERFERENCE S7. INTERFERENCE | 58. SHIELDING                         |  |  |  |  |  |  |  |
| INTERPERENCE INTERPERENCE INTERPERENCE                          |                                       |  |  |  |  |  |  |  |
| 59. CALIBRATION 60. DATA RECOVERY                               | 61. FREQUENCY OF OBSERVATION          |  |  |  |  |  |  |  |
| REALTIME TELEME   | TRY EVERY 28 MINUTES                  |  |  |  |  |  |  |  |
| 62. TELEMETRY REQUIREMENTS                                      |                                       |  |  |  |  |  |  |  |
| 500 KBIT, 3 TDM CHANNELS OF 150 KBIT EACH.                      |                                       |  |  |  |  |  |  |  |
|   |                                       |  |  |  |  |  |  |  |
|   |                                       |  |  |  |  |  |  |  |
| 63. ADVANTAGES AND LIMITATIONS                                  |                                       |  |  |  |  |  |  |  |
| REDUCTION IN SIZE AND WEIGHT OVER COMBIN                        | NED TELESCOPE-PHOTOMULTI-             |  |  |  |  |  |  |  |
| PLIER TUBE ASSEMBLY.  |                                       |  |  |  |  |  |  |  |
| 64. REFERENCES  | -                                     |  |  |  |  |  |  |  |
| 1) ATS METEOROLOGICAL DATA CATALOG. GSFC.                       | · · · · · · · · · · · · · · · · · · · |  |  |  |  |  |  |  |
| INTERIM REPORT ON SATELLITE MET. INSTRUM                        |                                       |  |  |  |  |  |  |  |
| PR67.***3)SUOMI, V. AND PARENT, R.J.: PR                        |                                       |  |  |  |  |  |  |  |
| FOR SPIN SCAN CAMERA FOR ATS C. UNIV. OF                        |                                       |  |  |  |  |  |  |  |
| *4)DATA AVAILABLE FROM ESSA, ASHEVILLE,                         |                                       |  |  |  |  |  |  |  |
| BUS/ATS DATA UTILIZATION CENTER. GSFC. F                        | FOR COLOR.                            |  |  |  |  |  |  |  |
| 65. HISTORICAL REMARKS  |                                       |  |  |  |  |  |  |  |
| ADVANCEMENT OVER MULTICOLOR SPIN-SCAN CA                        | AMERA (SSCC) ON ATS I                 |  |  |  |  |  |  |  |
|   |                                       |  |  |  |  |  |  |  |
|   |                                       |  |  |  |  |  |  |  |
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| 1. TITLE             |                   |        |                    |         |                   |                  | 2. 4               | CRONYM    | 3. EXP NO       |  |  |
|----------------------|-------------------|--------|--------------------|---------|-------------------|------------------|--------------------|-----------|-----------------|--|--|
| VIDICON (            | CAMERA SYSTEM     | 1      |                    |         |                   |                  | VC                 | SM        |                 |  |  |
| (TITLE CONT.         | ) .               |        |                    |         |                   |                  | 4. RI              | SUME DATE | 5.<br>VERSION   |  |  |
| MEDIUM-A!            | VGLE LENS         |        |                    |         |                   |                  | 0.9                | 701/      |                 |  |  |
| 6. PRINCIPAL IN      | IVESTIGATOR       | 7. OR  | GANIZATION         | -       |                   | 8. TI            | ELEPHO             | EPHONE    |                 |  |  |
| RADOS, R             | .M. (MGR.)        | GOD    | DARD SPACE FI      | LTC     | ENTER             | 30               | 1-982              | -5042     | 2               |  |  |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION         | 11. T   | ELEPHO            | NE               |                    |           |                 |  |  |
|                      |                   |        |                    |         |                   |                  |                    |           |                 |  |  |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | MBER    | 15. START<br>DATE | 16. <sup>C</sup> | OMPLETION<br>DATE  | 17. STAT  | US              |  |  |
|                      |                   |        |                    |         | POST              | FLIGHT           |                    |           |                 |  |  |
| 18. MONITOR          |                   | 19. AG | ENCY               | 20. PGI | M OFFICE          | 21. T            | ELEPHO             | NE        |                 |  |  |
| TEPPER,              | ٧                 | NAS    | A HDQTRS           | DA      | 'ERD              | 20               | 2-755              | 2322      | 2               |  |  |
| 22. VENDOR           |                   |        | 23. LOCATION       | ·       |                   | •                | 24. FLIGHT<br>DATE | 25. L     | EAD TIME        |  |  |
| PCA ASTR             | O-ELECTRONICS     | S      | PRINCETON,         | NEW     | JERSE'            | Y                | 02/6               | 2 NA      |                 |  |  |
| 26. INSTRUMEN        | T TYPE            |        |                    |         | ,                 |                  |                    |           | 27.<br>SECURITY |  |  |
| IMAGER,              | 0.5-INCH MED      | IUM /  | ANGLE F/1.8        | VIDI    | CON               |                  |                    |           | UNC             |  |  |
| 28. APPLICATIO       | N                 |        |                    |         | 29. SPACE         | CRAF             | T                  |           |                 |  |  |
| MET                  |                   |        |                    |         | TIROS             | 4                |                    |           |                 |  |  |
| 30. PURPOSE          |                   |        |                    |         |                   |                  |                    |           |                 |  |  |

PRIMARY-TO PROVIDE PICTURES OF EARTH'S CLOUD COVER AND INVESTI-GATE FORMATIVE STAGES OF HURRICANES AND ATMOSPHERIC MOTIONS. \*\*\* SECONDARY-TO CONFIRM THE CAPABILITY OF USING A WEATHER SATELLITE FOR ICE RECONAISSANCE.

#### 31. PRINCIPLES OF OPERATION

THIS MEDIUM ANGLE VIDICON CAMERA SYSTEM WAS ALSO FLOWN, IN IDEN-TICAL CONFIGURATION, ON TIROS 5 AND 6. IT CONSISTS OF A 1/2-INCH VIDICON TUBE AND A FOCAL-PLANE SHUTTER THAT PERMITS STORAGE OF STILL PICTURES ON THE TUBE SCREEN. AN ELECTRON BEAM CONVERTS THE STORED PICTURES INTO TELEVISION-TYPE ELECTRONIC SIGNALS, WHICH CAN BE TRANSMITTED TO GROUND RECEIVERS ON COMMAND. THE SYSTEM CAN ALSO PROCESS AND STORE UP TO 32 PICTURES ON MAGNETIC TAPE FOR TRANSMISSION AT A LATER TIME. THE CAMERA HAS A MEDIUM ANGLE (76 DEGREES) TEGEA F/1.8 LENS PRODUCING A RESOLUTION OF ABOUT 1.0 MILE. THE CAMERA HAS A SHUTTER SPEED OF 1.5 MILLISECONDS AND A VIDEO-BANDWIDTH OF 62.5 KHZ. THE 500 LINE FRAME IS PROCESSED FOR STORAGE IN 12 SECS. A MINIMUM INTERVAL, BETWEEN PICTURES, OF 10 SECONDS IS REQUIRED FOR THE TARGET IMAGE TO BE ELECTRICALLY ERASED. THE CAMERA IS ALIGNED PARALLEL TO THE SATELLITE'S SPIN AXIS AND IS AUTOMATICALLY TRIGGERED SO AS TO BE IN A PICTURE TAKING MODE ONLY WHEN DIRECTED TOWARD THE EARTH. TRANSMISSION OF THE ENTIRE REEL OF 32 PICTURES CAN BE ACCOMPLISHED IN 100 SEC-ONDS BY A 2-WATT FM TRANSMITTER OPERATING AT A NOMINAL FREQUENCY OF 235 MHZ.

#### 32. PHENOMENA OBSERVED

CLOUD COVER OVER THE EARTH'S SURFACE

33. MEASUREMENT RANGE

7 TO 8 LEVELS OF GRAY

| [05_0050=0.4. =          |           |                     |          |                    |              |          | 1             |          |         |            |          |              | 1        |          |         |             |
|--------------------------|-----------|---------------------|----------|--------------------|--------------|----------|---------------|----------|---------|------------|----------|--------------|----------|----------|---------|-------------|
| 35. SPECTRAL R           |           |                     |          | 7.5                | ., -         | C D C :  |               | SPEC     | TRA     | LRE        | SOLU     | TION         | 37.1     | IME      | ONST    | ANT         |
| 0 • 5<br>38. FIELD OF VI |           | 0                   | 0        | • 65               |              |          | VS N          |          |         |            |          |              |          |          |         | -           |
|                          |           |                     |          |                    | 39. GR       |          |               |          | N 1 N 4 | <u> </u>   | 214      |              | NI M     | A 1 T    | TTUD    |             |
|                          | 3 Y       |                     |          | DEG                |              |          | 3 Y 5         | 00       | MM      | FK!        | <u> </u> | 450          | NM       | ALI      | 1100    | <u> </u>    |
| 40. ANGULAR RESO         |           | +                   |          |                    |              |          | <u>-</u>      | 0.044    | , -     |            |          | A 1 T        | TUO      |          |         |             |
| 0.12                     |           |                     | O NM     |                    | RTV          | T        |               |          | 42      | ) ( )      | r        |              |          |          |         |             |
| 42. POINTING ACCU        | RACY      | 43. PO              | INTING   | RATE               |              |          | LTITU         |          |         | _          |          |              | ATION    |          | 2010    | DADE        |
| 46 6050141 05            |           |                     | ·        |                    |              | ME       | ) <u></u>     | IRC      | ULA     | K          | MIT      | DIU          | 7:       | - PI     | J 3 1 G | RADE        |
| 46. SPECIAL RE           | UUIKE     | MENI                | 5        |                    |              |          |               |          |         |            |          |              |          |          |         |             |
| 47 COMPONIENT            |           |                     |          |                    |              |          |               |          |         |            |          |              |          |          |         |             |
| 47. COMPONENT            |           | D A At              | CMTT     | TED                | TAD          | T 0      | C O D         | חבם      |         |            |          |              |          |          |         |             |
| TV CAMERA  48. WEIGHT    | 49. VO    |                     |          | IER                | ·            |          | POWER         |          | ANDR    | V POV      | ue p     | 52 PE        | AK PO    | NER      | 53. M   | TRE         |
| 7 LB                     | 49. VC    | LOWIE               |          |                    | 30. AV       |          |               | +        |         | 11 701     | VEN      |              | WA       |          | 33. 141 | 101         |
| 54. INTERFERENCE         | 55 1      | AAGNETIC<br>ERFEREN | :        | Se NU              | CLEAR        |          | ATTS          |          |         | F0 C       | <u> </u> | DING         | HA       | 113      |         |             |
| INTERFERENCE             |           |                     |          | +                  | FERENCE      |          | INTERFE       | RENCE    |         |            |          |              | CHI      | C 1 D    | TNC     | HEED        |
| 59. CALIBRATIO           |           | 1 C F               | TIVE     | 1                  | len.         | DATA     | RECOV         | EPY      | L       | MAI        | JIVE     |              | PEONENC  |          |         | USED        |
| NO IN-FLI                |           | C A !               | חמן ו    | ATIO               |              |          |               |          | EAI     | 711        | 4 E      |              | SID      |          |         |             |
| 62. TELEMETRY            |           |                     |          | AILU               | MIDE         | LAT      | IV U          | r KI     | LAL     | 3 11 7     | יו כ'    | LUA'         | 310      | <u> </u> | UK      | DII         |
| FULL REEL                |           |                     |          | TUPE               | S C A        | N R      | - D C         | A D 1    | 7117    |            | 1 1      | 00 9         | ECO      | ND S     | HCT     | NG          |
| AN FM TRA                |           |                     |          |                    |              |          |               |          |         |            |          |              |          | 103      | 031     | NO          |
| ANTE                     | 114.214   | 1 1 1               | LK U     | FERM               | HING         | , 41     | FNE           | (4 O C ) | VC I    | U          | ۷.       | י ככ         | 1117 .   |          |         |             |
| 63. ADVANTAG             | ES AN     | D LIM               | ITATIO   | NS                 |              |          |               |          |         |            |          |              |          | ·        |         | <del></del> |
| BROAD SYN                | IODT      | T C                 | VIEW     | INC                | OE C         | 1 011    | 2-00          | VED      | DA      | TT         | EDM      | <u> </u>     | / 61 11  | ARIG     | E E O   | D           |
| ICE STUDY                |           |                     |          |                    |              |          |               | ACL      | F 44    |            | \ \ \    | <b>3</b> • • | ALU      | H D L    | . 10    |             |
| 64. REFERENCE            |           | U I                 | CL N     | E C UN             | MAIS         | 3 4/11   | <u>√ E. ♦</u> |          |         |            |          |              |          |          |         |             |
| 1) SIGNIF                |           | NT                  | ACHI     | EVEM               | ENTS         | ŧΝ       | CAT           | FI 1     | TTE     | MI         | TE       | าคาเ         | nev      | . 10     | 358-    | 1064        |
| NASA SP-9                |           |                     |          |                    |              |          |               |          |         |            |          |              |          | •        |         |             |
| SP-3028.*                |           |                     |          |                    |              |          |               |          |         |            |          |              |          |          |         |             |
| 62-24; 62                |           |                     |          |                    |              |          |               |          |         |            | -        |              |          |          |         |             |
| RECORDS C                |           |                     |          |                    |              |          |               |          |         | <b>L</b> L | 1 10     | J = 1        | 4M 1 1 1 | UNMI     | . ".    | AIIIEN      |
| INECONDS C               |           | L11                 | ( 633    | <i>~,</i> ~        | 311E. V      | 166      | _ 9 14        | • • •    |         |            |          |              |          |          |         |             |
| 65. HISTORICAL           | REM/      | ARKS                |          |                    |              |          |               |          |         |            |          |              |          |          |         |             |
| IDENTICAL                | IN        | STRI                | IMEN     | TS F               | LOWN         | ΠN       | TIR           | ns 4     | 4.      | 5.         | ΔΝΙ      | 7 6.         |          |          |         |             |
| 1020                     | • • • • • | <u> </u>            | <u> </u> | <del>, , , ,</del> | <u>L</u> OMI | <u> </u> | 1             |          | · •     |            |          |              | ·        |          |         |             |
|                          |           |                     |          |                    |              |          |               |          |         |            |          |              |          |          |         |             |
|                          |           |                     |          |                    |              |          |               |          |         |            |          |              |          |          |         |             |
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|                          |           |                     |          |                    |              |          |               |          |         |            |          |              |          |          |         |             |
|                          |           |                     |          |                    |              |          |               |          |         |            |          |              |          |          |         |             |
|                          |           |                     |          |                    |              |          |               |          |         |            |          |              |          |          |         |             |
|                          |           |                     |          |                    |              |          |               |          |         |            |          |              |          |          |         |             |
|                          |           |                     |          |                    |              |          |               |          |         |            |          |              |          |          |         |             |
|                          |           |                     |          |                    |              |          |               |          |         |            |          |              |          |          |         |             |
| •                        |           |                     |          |                    |              |          |               |          |         |            |          |              |          |          |         |             |
|                          |           |                     |          |                    |              |          |               |          |         |            |          |              |          |          |         |             |
|                          |           |                     |          |                    |              |          |               |          |         |            |          |              |          |          |         |             |
|                          |           |                     |          |                    |              |          |               |          |         |            |          |              |          |          |         |             |
|                          |           |                     |          |                    |              |          |               |          |         |            |          |              |          |          |         |             |
| 1                        |           |                     | ,        |                    |              |          |               |          |         |            |          |              |          |          |         |             |
|                          |           |                     |          |                    |              |          |               |          |         |            |          |              |          |          |         |             |
|                          |           |                     |          |                    |              |          |               |          |         |            |          |              |          |          |         |             |
|                          |           |                     |          |                    |              |          |               |          |         |            |          |              |          |          |         |             |
|                          |           |                     |          |                    |              |          |               |          |         |            |          |              |          |          |         |             |
|                          |           |                     |          |                    |              |          |               |          |         |            |          |              |          |          |         |             |

| 1. TITLE             |                   |        |                    |                  |                   |         | 2.4                | ACRONYM    | 3. I | XP NO           |  |
|----------------------|-------------------|--------|--------------------|------------------|-------------------|---------|--------------------|------------|------|-----------------|--|
| VIDICON              | CAMERA SYSTE      | Ч      |                    |                  |                   |         |                    | CSM        |      |                 |  |
| (TITLE CONT.         |                   |        |                    |                  |                   |         | 4. R               | ESUME DATE |      | 5.<br>VERSION   |  |
| MEDIUM-A             | NGLE LENS         |        |                    |                  |                   |         | 0.0                | 9/01/      | 72   | 0005            |  |
| 6. PRINCIPAL II      | NVESTIGATOR       | 7. OR  | GANIZATION         |                  |                   | 8. TI   | ELEPHO             | NE         |      |                 |  |
| RADOS, R             | .M. (MGR.)        | GOD    | DARD SPACE FI      | LTC              | ENTER             | 30      | 1-982              | 982-5042   |      |                 |  |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION         |                  |                   | 11. T   | ELEPHO             | NE.        |      |                 |  |
|                      |                   |        |                    |                  | 15. START<br>DATE |         |                    |            |      |                 |  |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | 16. <sup>C</sup> | OMPLETION<br>DATE | 17. STA | rus                |            |      |                 |  |
|                      |                   |        |                    |                  |                   | POST    | FL                 | IGHT       |      |                 |  |
| 18. MONITOR          |                   | 19. AG | ENCY               | 20. PGM          | OFFICE            | 21. T   | ELEPHO             | DNE        |      | •               |  |
| TEPPER,              | М.                | NAS    | A HDQTRS           | OA/              | EŔD               | 20.     |                    | 5-232      | 2    |                 |  |
| 22. VENDOR           |                   |        | 23. LOCATION       |                  |                   |         | 24. FLIGHT<br>DATE | 7 25. L    | .EAD | TIME            |  |
| RCA ASTR             | O-ELECTRONIC      | S      | PRINCETON,         | NEW .            | JERSE             | Υ ·     | 06/6               | 52 NA      |      |                 |  |
| 26. INSTRUMEN        | IT TYPE           |        |                    |                  |                   |         |                    |            |      | 27.<br>SECURITY |  |
| IMAGER,              | 0.5-INCH MED      | IUM-   | ANGLE F/1.8        | VIDI             | CON               |         |                    |            |      | UNC             |  |
| 28. APPLICATIO       | N                 |        |                    | 2                | 9. SPACE          | CRAF    | T                  |            |      |                 |  |
| MET                  |                   |        |                    |                  | TIROS             | 5.      |                    |            |      |                 |  |
| 30. PURPOSE          |                   |        |                    |                  |                   |         |                    |            |      |                 |  |

PRIMARY-TO PROVIDE PICTURES OF EARTH'S CLOUD COVER AND INVESTIGATE FORMATIVE STAGES OF HURRICANES AND ATMOSPHERIC MOTIONS. \*\*\* SECONDARY-TO CONFIRM THE CAPABILITY OF USING A WEATHER SATELLITE FOR ICE RECONAISSANCE.

#### 31. PRINCIPLES OF OPERATION

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#### 32. PHENOMENA OBSERVED

CLOUD COVER OVER THE EARTH'S SURFACE

33. MEASUREMENT RANGE

7 TO 8 LEVELS OF GRAY

| 35. SPECTRAL RANGE                      |                              | 36. SPECTRAL RESOLU | UTION 37. TIME CONSTANT      |
|---|------------------------------|---------------------|------------------------------|
| 0.5 TO 0.65                             | MICRONS                      | NA                  |                              |
| 38. FIELD OF VIEW                       | 39. GROUND SWA               |                     |                              |
|   |                              | 480 NM FROM         | 450 NM ALTITUDE              |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESC | LUTION                       |                     |                              |
| 0.12 DEG 1.0 NM PE                      | R TV-LINE                    | FROM 450 NM         | ALTITUDE                     |
| 42. POINTING ACCURACY 43. POINTING RATE | 44. ALT                      | TUDE 45.            | INCLINATION                  |
|   | MED                          |                     | DIUM POSIGRADE               |
| 46. SPECIAL REQUIREMENTS                |                              |                     |                              |
|   |                              | <u></u>             |                              |
| 47. COMPONENTS                          | or vin . ,                   | 1 0 80              | <del></del>                  |
| TV CAMERA, TRANSMITTER,                 | TADE RECO                    | IRDER               |                              |
| 48. WEIGHT 49. VOLUME                   | 1                            | · *                 | 52. PEAK POWER 53. MTBF      |
| 7 LB                                    |                              | S NONE              | 9 WATTS                      |
|   |                              |                     |                              |
|   | SCLEAR<br>REFERENCE 57. INTE |                     |                              |
| SENSITIVE                               |                              |                     | TIC SHIELDING USED           |
| 59. CALIBRATION                         | 60. DATA REC                 |                     | 61. FREQUENCY OF OBSERVATION |
| NO IN-FLIGHT CALIBRATIC                 | NIDELAYED                    | OR REALTIME         | DAY SIDE OF ORBIT            |
| 62. TELEMETRY REQUIREMENTS              |                              |                     |                              |
| FULL REEL OF 32 PICTURE                 | S CAN BE                     | READ OUT IN 1       | OO SECONDS USING             |
| AN EM TRANSMITTER OPERA                 | TING AT FR                   | REQUENCY DF 2       | 35 MHZ.                      |
|   |                              |                     |                              |
| 63. ADVANTAGES AND LIMITATIONS          |                              |                     |                              |
| BROAD SYNOPTIC VIEWING                  | OF CLOUD (                   | OVER PATTERY        | S. VALUABLE FOR              |
| ICE STUDY AND ICE RECON                 |                              |                     |                              |
| 64. REFERENCES                          |                              |                     |                              |
| 1) SIGNIFICANT ACHIEVEM                 | ENTS IN S                    | TELLITE METE        | OPDIOCY 1959-1964            |
|   |                              |                     |                              |
| NASA SP-96. ***2) [NSTRU                |                              |                     |                              |
| SP-3028.***3) NASA NEWS                 |                              |                     |                              |
| 62-24; 62-136; 62-194.*                 |                              |                     | UM NATIUNAL WEATHER          |
| RECORDS CENTER (ESSA) A                 | SHEVILLE,                    | N • C •             |                              |
| CE HISTORICAL DEMANA                    |                              |                     |                              |
| 65. HISTORICAL REMARKS                  |                              |                     |                              |
| IDENTICAL INSTRUMENTS F                 | LOWN ON T                    | IROS 4, 5, AN       | D 6.                         |
|   |                              |                     |                              |
|   |                              |                     |                              |
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### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER

GREENBELT, MD. 20771

| 1. TITLE             |                   | 72             |                   | 2. /   | ACRONYM           | 3.1    | EXP NO            |            |     |                 |
|----------------------|-------------------|----------------|-------------------|--------|-------------------|--------|-------------------|------------|-----|-----------------|
| VIDICON (            | AMERA SYSTEM      | 1              |                   |        |                   |        | VC                | SM         |     |                 |
| (TITLE CONT.         | )                 |                |                   |        |                   |        | 4. R              | ESUME DATE |     | 5.<br>VERSION   |
| MEDIUM-AN            | IGLE LENS         |                |                   |        |                   |        | Ü                 | 9/01/      | 72] | 0005            |
| 6. PRINCIPAL IN      | NVESTIGATOR       | 7. OR          | GANIZATION        |        |                   | 8. TE  | LEPHO             | NE         |     |                 |
| RADOS, R.            | M. (MGR.)         | GODE           | DARD SPACE F      | LT CI  | ENTER             | 301    | -982              | 2-5042     | 2   |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR         | GANIZATION        | 11. T  | ELEPHO            | ONE    |                   |            |     |                 |
|                      |                   |                |                   |        |                   |        |                   |            |     |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER             | 14. FLASH INDEX N | UMBER  | 15. START<br>DATE | 16. CC | OMPLETION<br>DATE |            |     |                 |
|                      |                   |                |                   |        | POST              | FL     | IGHT              |            |     |                 |
| 18. MONITOR          |                   | 19. AG         | ENCY              | OFFICE | 21. T             | ELEPH  | ONE               |            |     |                 |
| TEPPER, N            | 1.                | NAS            | A HDQTRS          | OA/I   | ERD               | 202    | 2-755             | -2322      | 2   |                 |
| 22. VENDOR           |                   |                | 23. LOCATION      |        |                   |        | 24. FLIGH<br>DATE | ' 25. l    | EAD | TIME            |
| RCA ASTRO            | D-ELECTRONICS     | 5              | PRINCETON,        | NEW .  | JER SE'           | ′      | 09/6              | 2 NA       |     |                 |
| 26. INSTRUMEN        | T TYPE            |                |                   |        |                   |        |                   |            |     | 27.<br>SECURITY |
| IMAGER, (            | .5-INCH MED!      | [UM-A          | ANGLE F/1.8       |        |                   |        |                   | UNC        |     |                 |
| 28. APPLICATIO       | N .               | 29. SPACECRAFT |                   |        |                   |        |                   |            |     |                 |
| MET                  |                   |                |                   |        |                   |        |                   |            |     |                 |
| 30. PURPOSE          |                   |                |                   |        |                   |        |                   |            |     |                 |

PRIMARY-TO PROVIDE PICTURES OF EARTH'S CLOUD COVER AND INVESTI-GATE FORMATIVE STAGES OF HURRICANES AND ATMOSPHERIC MOTIONS.\*\*\* SECONDARY-TO CONFIRM THE CAPABILITY OF USING A WEATHER SATELLITE FOR ICE RECONAISSANCE.

#### 31. PRINCIPLES OF OPERATION

THIS MEDIUM ANGLE VIDICON CAMERA SYSTEM WAS ALSO FLOWN. IN IDEN-TICAL CONFIGURATION, ON TIROS 4 AND 5. IT CONSISTS OF A 1/2-INCH VIDICON TUBE AND A FOCAL-PLANE SHUTTER THAT PERMITS STORAGE OF STILL PICTURES ON THE TUBE SCREEN. AN ELECTRON BEAM CONVERTS THE STORED PICTURES INTO TELEVISION-TYPE ELECTRONIC SIGNALS, WHICH CAN BE TRANSMITTED TO GROUND RECEIVERS ON COMMAND. THE SYSTEM CAN ALSO PROCESS AND STORE UP TO 32 PICTURES ON MAGNETIC TAPE FOR TRANSMISSION AT A LATER TIME. THE CAMERA HAS A MEDIUM ANGLE (76 DEGREES) TEGEA F/1.8 LENS PRODUCING A RESOLUTION OF ABOUT 1.0 MILE. THE CAMERA HAS A SHUTTER SPEED OF 1.5 MILLISECONDS AND A VIDEO-BANDWIDTH OF 62.5 KHZ. THE 500 LINE FRAME IS PROCESSED FOR STORAGE IN 12 SECS. A MINIMUM INTERVAL, BETWEEN PICTURES, OF 10 SECONDS IS REQUIRED FOR THE TARGET IMAGE TO BE ELECTRICALLY ERASED. THE CAMERA IS ALIGNED PARALLEL TO THE SATELLITE'S SPIN AXIS AND IS AUTOMATICALLY TRIGGERED SO AS TO BE IN A PICTURE TAKING MODE ONLY WHEN DIRECTED TOWARD THE EARTH. TRANSMISSION OF THE ENTIRE REEL OF 32 PICTURES CAN BE ACCOMPLISHED IN 100 SECONDS BY A 2-WATT FM TRANSMITTER OPERATING AT A NOMINAL FRE-QUENCY OF 235 MHZ.

#### 32. PHENOMENA OBSERVED

CLOUD COVER OVER THE EARTH'S SURFACE

33. MEASUREMENT RANGE

7 TO 8 LEVELS OF GRAY

| for opening a succession   |  |
|--|--|
| 35. SPECTRAL RANGE   | 36. SPECTRAL RESOLUTION 37. TIME CONSTANT  |
|  | RONS NA  |
|  | ND SWATH   |
|  | M BY 450 NM FROM 400 NM ALTITUDE   |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION  | FROM AND NM ALTITUDE   |
|  | FROM 400 NM ALTITUDE   |
| The second secon | 44. ALTITUDE 45. INCLINATION   |
|  | MED CIRCULAR MEDIUM POSIGRADE  |
| 46. SPECIAL REQUIREMENTS   |  |
| 47 COMPONIENTO   |  |
| TV, CAMERA, TRANSMITTER, TAPE  | DECADAGO   |
|  | The state of the s |
| The second secon | AGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF 9 WATTS  |
|  |  |
| the second secon | 57. THERMAL ST. INTERFERENCE SHIELDING MACAISTIC SHIELDING   |
| SENSITIVE  | MAGNETIC SHIELDING USED  |
|  | ATA RECOVERY 61. FREQUENCY OF OBSERVATION  |
| 62. TELEMETRY REQUIREMENTS   | AYED OR REALTIME DAY SIDE OF ORBIT   |
|  | DE BEAD OUT IN 100 CCCOMDC MCTMG   |
| AN FM TRANSMITTER OPERATING  | BE READ OUT IN 100 SECONDS USING   |
| AN EM INANSMITTER UPERATING  | AT FREQUENCT OF 233 MML.   |
| 63. ADVANTAGES AND LIMITATIONS   |  |
|  | OUD COVER PATTERNS. VALUABLE FOR   |
| ICE STUDY AND ICE RECONNAISS   |  |
| 64. REFERENCES   | M!YU C •   |
|  | -1044 NACA CD-04 +++317NCTSIMENTO  |
|  | -1964.NASA SP-96.***2)INSTRUMENTS  |
|  | . NASA SP-3028. ****3) NASA NEWS RE-   |
|  | ASE NO'S. 62-24;62-136;62-194.***  |
| 4)DATA AVAILABLE FROM NATIONA  | HE MEATHER RECURUS CIRTESSAT   |
| ASHEVILLE, N.C.  |  |
| 65. HISTORICAL REMARKS   |  |
| IDENTICAL INSTRUMENTS FLOWN C  | DN TIRDS 4. 5. AND 6.  |
| IDENTICAL INSTRUMENTS PLUMN L  | JN TIRUS 4, 5, AND 6.  |
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| 1. TITLE             |                   |        |                    | 2. /   | ACRON             | . EXP NO          |                    |                        |                |                 |  |  |
|----------------------|-------------------|--------|--------------------|--------|-------------------|-------------------|--------------------|------------------------|----------------|-----------------|--|--|
| VIDICON              | CAMERA SYSTE      | M      |                    |        |                   |                   | V                  | CSN                    |                |                 |  |  |
| (TITLE CONT.         | )                 | _      |                    |        |                   |                   | 4. R               | ESUME I                | DATE           | 5.<br>VERSION   |  |  |
| NARROW-A             | NGLE LENS         |        |                    |        |                   |                   | e e                | 9/0                    | 1/72           | 2 0004          |  |  |
| 6. PRINCIPAL II      | NVESTIGATOR       | 7. OR  | GANIZATION         |        |                   | 8. TE             | LEPHO              | EPHONE                 |                |                 |  |  |
| STROUD,              | W.G. (MGR)        | GOD    | DARD SPACE F       | LT C   | ENTER             | 30                | 1-982              | -982 <del>-</del> 5042 |                |                 |  |  |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION         |        |                   | 11. T             | ELEPHO             | NE                     |                |                 |  |  |
|                      |                   |        |                    |        | 15. START<br>DATE |                   |                    |                        |                |                 |  |  |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | MBER   | 16. Ct            | DMPLETION<br>DATE | 17. S              | S                      |                |                 |  |  |
|                      |                   |        |                    |        | PO:               | ST F              | LIGHT              |                        |                |                 |  |  |
| 18. MONITOR          |                   | 19. AG | ENCY               | OFFICE | 21. T             | ELEPHO            | ONE                |                        |                |                 |  |  |
| TEPPER,              | м                 | NAS    | A HDQTRS           | DAZ    | ERD               | 20                | 2-75               | 5 <b>-</b> 2:          |                |                 |  |  |
| 22. VENDOR           |                   |        | 23. LOCATION       |        | •                 |                   | 24. FLIGHT<br>DATE | 2                      | 5. LE <i>A</i> | D TIME          |  |  |
| RCA ASTR             | O-ELECTRONIC      | S      | PRINCETON.         | NEW    | JERSE             | Υ                 | 04/                | 50 I                   | NA             |                 |  |  |
| 26. INSTRUMEN        | T TYPE            |        |                    |        |                   |                   |                    |                        |                | 27.<br>SECURITY |  |  |
| IMAGER.              | NARROW-ANGLE      | F/1    | .8 0.5-INCH        | UN     |                   |                   |                    |                        |                |                 |  |  |
| 28. APPLICATIO       | N :               |        | 29. SPACECRAFT     |        |                   |                   |                    |                        |                |                 |  |  |
| MET                  |                   |        |                    |        | TIROS             | 1                 |                    |                        |                |                 |  |  |
| 30. PURPOSE          |                   |        |                    |        |                   |                   |                    |                        |                |                 |  |  |

PRIMARY-TO ACQUIRE AND TRANSMIT (PEALTIME OR DELAYED) PICTURES OF THE EARTHS CLOUD COVER SHOWING SPECIFIC CLOUD TYPES IN GREAT-ER DETAIL THAN WIDE AND MEDIUM ANGLE CAMERAS.

#### 31. PRINCIPLES OF OPERATION

THIS NARROW ANGLE VIDICON CAMERA IS IDENTICAL TO THE ONE THAT WAS FLOWN SUBSEQUENTLY ON TIROS 2. IT CONSISTS OF A 1/2-INCH VIDICON TUBE AND A FOCAL-PLANE SHUTTER THAT PERMITS STORAGE OF STILL PICTURES ON THE TUBE SCREEN. AN ELECTRON BEAM CONVERTS THE STORED PICTURES INTO TELEVISION-TYPE ELECTRONIC SIGNALS, WHICH CAN BE TRANSMITTED TO GROUND RECEIVERS ON COMMAND. THE SYSTEM CAN ALSO PROCESS AND STORE UP TO 32 PICTURES ON MAGNETIC TAPE FOR TRANSMISSION AT A LATER TIME. THE CAMERA HAS A NARROW ANGLE (12 DEGREES) CINEGOR F/1.5 LENS PRODUCING A RESOLUTION OF ABOUT 1000 FEET. THE PHOTOGRAPHS ARE WITHIN THE WIDE-ANGLE CAMERA VIEWS. THE CAMERA HAS A SHUTTER SPEED OF 1.5 MILLISECONDS AND A VIDEO BANDWIDTH OF 62.5 KHZ. THE 500 LINE FRAME IS PROCESSED FOR STORAGE IN 2 SEC. A MINIMUM INTERVAL OF 10 SECONDS BETWEEN PIC-TURES IS REQUIRED FOR THE TARGET IMAGE TO BE ELECTRICALLY ERASED THE CAMERA IS ALIGNED PARALLEL TO THE SATELLITES SPIN AXIS AND IS AUTOMATICALLY TRIGGERED SO AS TO BE IN A PICTURE TAKING MODE ONLY WHEN DIRECTED TOWARD THE EARTH. TRANSMISSION OF THE ENTIRE REEL OF 32 PICTURES CAN BE ACCOMPLISHED IN 10 SECONDS BY 4 2-WATT FM TRANSMITTER OPERATING AT A NOMINAL FREQUENCY OF 235 MHZ.

#### 32. PHENOMENA OBSERVED

CLOUD COVER OVER THE EARTH'S SURFACE

#### 33. MEASUREMENT RANGE

5 LEVELS OF GRAY

| 35. SPECTRAL   | RANGE  |  |   | 3(                           | S. SPECTRA             | AL RESOL                 | UTION  | 37. TIME   | CONSTANT   |
|--|--|--|---|------------------------------|------------------------|--------------------------|--|--|--|
| 0.4  |  | 0.6  |   | ICRON                        |                        |                          |  | <u> </u>   |  |
| 38. FIELD OF V   | IEW  |  | 39. GR  | DUND SWATI                   | 1                      |                          |  |  |  |
| 10.0   | BY 10  | 0.0 DE   | G 54 1  | VM BY 5                      | 4 NM F                 | ROM 4                    | 50 NM  | ALTI   | TUDE   |
| 40. ANGULAR RES  | and the second second second   | The second secon |   | the same and the same is the |                        |                          |  |  |  |
| 0.02   | DEG 8  | OC FT P  | ER TV   | LINE F                       | ROM 45                 | O NM                     | ALTIT  | UDE  |  |
| 42. POINTING ACC   | URACY 43. PC   | DINTING RA   | TE  | 44. ALTITI                   | NAME OF TAXABLE PARTY. |                          | INCLINA  |  |  |
|  |  |  | -   | MED                          | CIRCUL                 | AR MI                    | EDIUM  | \!   | POSIGRADE  |
| 46. SPECIAL R  | EQUIREMEN'   | TS   |   |                              |                        |                          |  |  |  |
|  |  |  |   |                              |                        |                          |  |  |  |
| 47. COMPONEN   | Sefficient and the continues of  |  |   |                              |                        |                          | Tudu a an 200 Tudous   | er consumer consumer   | The state of the s |
| TV CAMER   | LA, TRAN   | <u>ISMITTE</u>   | WY THE HART & COLUMN TO SERVICE OF ST   |                              |                        |                          |  |  |  |
| 48. WEIGHT   | 49. VOLUM  | <u> </u>   | 50. AV  | ERAGE POWER                  | 51. STAND              | BY POWER                 | A popular and the same   | K POWER  | 53. MTBF   |
|  |  |  |   |                              |                        |                          |  | WATT:  | S  |
| 54 INTERFERENCE  | 55. MAGNET<br>INTERFERE  |  | NUCLEAR<br>NTERFERENCE  | 57. THEF                     | RENCE                  | 58. SHIE                 | All chic dinging Take on   |  |  |
|  | SENSI  | [TIVE]   |   |                              |                        | MAGN                     | The second second  | ADVIVOR DESCRIPTION OF THE PARTY OF THE PART | DING USED  |
| 59. CALIBRATI  |  |  | in management of the control of the | DATA RECO                    | <u> </u>               |                          |  | TV-R   | OBSERVATION  |
| NO IN-FL   | Constitution Thirty Constitution   | on the second resident of the second   | TON D   | ELAYED                       | DR REA                 | LTIME                    | DAY  | SIDE   | OF ORBIT   |
| 62. TELEMETR   | CAND TO All the Till Controlling To the  | MATERIAL STREET  |   |                              |                        |                          |  |  |  |
| FULL REE   |  |  |   |                              |                        |                          |  |  |  |
| USING AN   | I EM TRA   | INSMITT  | ER OPI  | ERATING                      | AT FR                  | EQUEN                    | CY OF  | 235 N  | 1HZ.   |
|  |  |  | · III · III JA VANCA AND A III AND AND AND AND AND AND AND AND AND AND  |                              |                        | aprampil man gram        |  |  |  |
| 63. ADVANTA  |  |  |   |                              |                        |                          |  |  |  |
| SHOWED C   | ETAILS   | OF SPE   | CIFIC   | CLOAD .                      | TYPES.                 |                          |  |  |  |
|  |  |  |   |                              |                        |                          | and the second s |  |  |
| 64. REFERENC   |  |  |   |                              |                        | Total comment            |  |  |  |
|  |  |  |   |                              |                        |                          |  |  | SP-96.***  |
| 21GOL DBE  |  |  |   |                              |                        |                          |  |  |  |
| NAUTICS,   |  |  |   |                              |                        |                          |  |  |  |
| TV CAMER   |  |  |   |                              |                        |                          |  |  |  |
| 4) INSTR   |  |  |   |                              |                        |                          |  |  |  |
| The second secon | THE RESERVE OF THE PROPERTY OF THE PERSON OF | Commence of the Commence of th | AL WEA  | THER RE                      | CORDS                  | CTR (                    | ESSA   | ) , A SHE  | VILLE, NC.   |
| 65. HISTORICA  |  | مسانسم ومسائلات والأساد  |   |                              |                        | way to the second second |  |  | · · · · · · · · · · · · · · · · · · ·  |
| IDENTICA   | L CAMER  | A ALSO   | FLOWN   | ON TIP                       | ROS 2                  |                          |  |  |  |
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| 1. TITLE             |                   |        |  |        |                   |                   | 2. A               | CRONYM    | 3. E | XP NO           |
|----------------------|-------------------|--------|--|--------|-------------------|-------------------|--------------------|-----------|------|-----------------|
| VIDICON (            | CAMERA SYSTE      | 4      |  |        |                   |                   | VC                 | SN        |      |                 |
| (TITLE CONT.         |                   |        |  |        |                   |                   |                    | SUME DATE |      | 5.<br>VERSION   |
| NARROW-A             | NGLE LENS         |        |  |        |                   |                   | 09                 | 7017      | 72]  | 0005            |
| 6. PRINCIPAL II      | NVESTIGATOR       |        | GANIZATION   |        |                   |                   | LEPHO              | VE .      |      |                 |
| STAMPFL,             | R.A. (MGR)        | GODI   | DARD SPACE FL  | T C    | ENTER             | 301               | 1-982              | -5042     | 2    |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION   |        |                   | 11. TI            | ELEPHO             | NE.       |      |                 |
|                      |                   |        |  |        |                   |                   |                    |           |      |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUME | ER     | 14. FLASH INDEX NU   | MBER   | 15. START<br>DATE | 16. <sup>CC</sup> | DATE               | 17. STA   | rus  |                 |
|                      |                   |        |  |        |                   |                   |                    | POST      | FL   | IGHT            |
| 18. MONITOR          |                   | 19. AG |  | OFFICE |                   | ELEPHO            |                    |           |      |                 |
| TEPPER, !            | Й.                | NAS    | HDQTRS   | DAZ    | ERD               | 202               |                    |           |      |                 |
| 22. VENDOR           | •                 |        | 23. LOCATION   |        |                   |                   | 24. FLIGHT<br>DATE | 25. L     | EAD  | TIME            |
| RCA ASTR             | O-ELECTRONIC:     | S      | PRINCETON, N   | IEW .  | JERSEY            | ′                 | 11/6               | O NA      |      |                 |
| 26. INSTRUMEN        |                   |        |  |        |                   |                   |                    |           |      | 27.<br>SECURITY |
| IMAGER, I            | NARROW-ANGLE      | F/1.   | .8 0.5-INCH \  |        |                   |                   | UNC                |           |      |                 |
| 28. APPLICATIO       | N.                |        |  | T      |                   |                   |                    |           |      |                 |
| MET                  |                   |        |  |        | TIROS             | 2.                |                    |           |      |                 |
| 20 01100000          |                   |        | and the second s |        |                   |                   |                    |           |      |                 |

30. PURPOSE

PRIMARY-TO ACQUIRE AND TRANSMIT(REALTIME OR DELAYED) PICTURES OF THE EARTH'S CLOUD COVER SHOWING SPECIFIC CLOUD TYPES IN GREATER DETAIL THAN WIDE AND MEDIUM ANGLE CAMERAS.

#### 31. PRINCIPLES OF OPERATION

THIS NARROW ANGLE VIDICON CAMERA IS IDENTICAL TO THE ONE THAT WAS FLOWN ON THE FIRST TIROS. IT CONSISTS OF A 1/2-INCH VIDICON TUBE AND A FOCAL-PLANE SHUTTER THAT PERMITS STORAGE OF STILL PICTURES ON THE TUBE SCREEN. AN ELECTRON BEAM CONVERTS THE STORED PICTURES INTO TELEVISION-TYPE ELECTRONIC SIGNALS, WHICH CAN BE TRANSMITTED TO GROUND RECEIVERS ON COMMAND. THE SYSTEM CAN ALSO PROCESS AND STORE UP TO 32 PICTURES ON MAGNETIC TAPE FOR TRANSMISSION AT A LATER TIME. THE CAMERA HAS A NARROW ANGLE (12 DEGREES) CINEGOR F/1.5 LENS PRODUCING A RESOLUTION OF ABOUT 850 FEET. THE PHOTOGRAPHS ARE WITHIN THE FOV OF A COMPANION CAMERA. THE CAMERA HAS A SHUTTER SPEED OF 1.5 MILLISECONDS AND A VIDEO-BANDWIDTH OF 62.5 KHZ. THE 500 LINE FRAME IS PROCESSED FOR STOR-AGE IN 2 SECS. A MINIMUM INTERVAL OF 10 SECONDS BETWEEN PICTURES IS REQUIRED FOR THE TARGET IMAGE TO BE ELECTRICALLY ERASED. THE CAMERA IS ALIGNED PARALLEL TO THE SATELLITES SPIN AXIS AND IS TURNED ON BY COMMAND. TRANSMISSION OF THE ENTIRE REEL OF 32 PICTURES CAN BE ACCOMPLISHED IN 100 SECONDS BY A 2-WATT FM TRANSMITTER OPERATING AT A NOMINAL FREQUENCY OF 235 MHZ.

#### 32. PHENOMENA OBSERVED

CLOUD COVER OVER THE EARTH'S SURFACE

#### 33. MEASUREMENT RANGE

7 TO 8 LEVELS OF GRAY

| 35. SPECTRAL RANGE   |  | L RESOLUTION   | 37. TIME CONSTANT   |
|--|--|--|---|
|  | CRON   |  |   |
| The state of the s | OUND SWATH   |  |   |
| 10.0 BY 10.0 DEG 54 N  |  | ROM 410 NM   | ALTITUDE  |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION  |  | Committee of the commit |   |
| C.02 DEG 850 FEET PER T  | The second secon |  |   |
| 42. POINTING ACCURACY 43. POINTING RATE  | 44. ALTITUDE   | 45. INCLINA  |   |
|  | MED CIRCULA  | AR MEDIUM  | POSI GRADE_   |
| 46. SPECIAL REQUIREMENTS   | <u></u>  | and the second s |   |
| The state of the s |  | The same and the s |   |
| 47. COMPONENTS   |  | er en este un reminimentario una el cara en el   | C C C C C C C C C C C C C C C C C C C   |
| TV CAMERA, TRANSMITTER, TAP  |  |  |   |
| the transfer of the second second second second second second second second second second second second second   | ERAGE POWER 51. STAND  |  | Name and the second companies of the second |
|  | 9 WATTS NONE   |  | WATTS   |
| S4- INTERFERENCE S5. INTERFERENCE S6. NUCLEAR  | 57. THERMAL<br>INTERFERENCE  | 58. SHIELDING  |   |
| SENSITIVE  |  | the state of the s | SHIELDING USED  |
| the state of the s | DATA RECOVERY  | 1  | QUENCY OF OBSERVATION   |
|  | LAYED OR REAL  | TIME [DAY  | SIDE OF ORBIT   |
| 62. TELEMETRY REQUIREMENTS   |  |  | . 100 0500  |
| FULL REEL OF 32 PICTURES CA  |  |  |   |
| USING AN EM TRANSMITTER OPE  | RATING AT FRE  | QUENCY OF  | 235 MHZ.  |
|  | -,   |  | www.u.u.usuqqq.u.uxuqqq.y   |
| 63. ADVANTAGES AND LIMITATIONS   |  | *  |   |
| SHOWED DETAILS OF SPECIFIC   | CLOUD TYPES  |  |   |
| 64. REFERENCES   | *  |  | C   |
| 1) SIGNIFICANT ACHIEVEMENTS  | IN SAT MET 19  | 958-1964.  | NASA SP-96.***  |
| 2) GOLDBERG, F.A. AND LANDON   |  |  |   |
| NAUTICS, V.5, JUNE 1960.***  | 3) MESNER, M.H   | . AND STAI   | NISZEWSKI, J.:  |
| TV CAMERAS FOR SPACE EXPLOR  | <ul> <li>ASTRONAUTIC</li> </ul>  | CS. V.5. M   | AY 1960.***   |
| 4) INSTRUMENTS AND SPACECRA  | FT. NASA SP-3  | 028, 1966  | . ***5) DATA  |
| AVAILABLE FROM NATIONAL WEAT   | THER RECORDS   | CTR (ESSA  | , ASHEVILLE, NC.  |
| 65. HISTORICAL REMARKS   |  |  |   |
| IDENTICAL INSTRUMENT FLOWN   | ON TIROS 1.  |  |   |
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|----------------------|-------------------|--------------------------------------|-----------|---------|-----------------|--------|--------------|-------------------|------------------|------|-----------------|
| 1. TITLE             |                   |                                      |           | 2.      | 2. ACRONYM 3. E |        |              |                   |                  |      |                 |
| VIDICON (            | CAMERA SYSTEM     | 4                                    |           |         |                 |        |              | V                 | CSW              |      |                 |
| (TITLE CONT.         | )                 |                                      |           |         |                 |        |              | 4. F              | ESUME DA         | re   | 5.<br>VERSION   |
| WIDE-ANG             | LE                |                                      |           |         |                 |        |              | 0.0               | 9/01/            | 772  | 0006            |
| 6. PRINCIPAL II      | NVESTIGATOR       | 7. OR                                | GANIZATIO | N       |                 |        | 8. TI        | ELEPHO            | NE               |      |                 |
| O'BRIEN,             | J.J.(T.MON)       | GOD                                  | DARD SP   | ACE FL  | T C             | ENTER  | 30           | 1-982             | 2-504            | +2   |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR                               | GANIZATIO | ELEPHO  | NE              |        |              |                   |                  |      |                 |
|                      |                   |                                      |           |         |                 |        |              |                   |                  |      |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | BER 14. FLASH INDEX NUMBER 15. START |           |         |                 |        |              | OMPLETION<br>DATE | 17. ST/          | ATUS |                 |
|                      |                   |                                      |           |         |                 |        |              |                   | POST             | F    | LIGHT           |
| 18. MONITOR          |                   | 19. AGENCY 20. PGM OFFIC             |           |         |                 |        | 21. T        | ELEPH             | ONE              |      |                 |
| GLOVER.              | J.C.              | NES                                  | C/NOAA    |         |                 |        | 202-655-4000 |                   |                  |      |                 |
| 22. VENDOR           |                   |                                      | 23. LOCAT | TION    |                 |        |              | 24. FLIGH<br>DATE | <sup>†</sup> 25. | LEA  | D TIME          |
| RCA ASTR             | O-ELECTRONICS     | 3                                    | PRINCE    | ETON, 1 | 1. J            | •      |              | 02/6              | 66               |      |                 |
| 26. INSTRUMEN        | T TYPE            |                                      |           |         |                 |        |              |                   |                  |      | 27.<br>SECURITY |
| IMAGER, (            | 5-INCH WIDE       | -ANGLE F/1.5 LOW-RESOLUTION V        |           |         |                 |        |              |                   | CON              |      |                 |
| 28. APPLICATIO       | N                 | 29. SPACECRAFT                       |           |         |                 |        |              | T                 |                  |      |                 |
| MET                  |                   |                                      |           |         |                 | ESSA : | l            |                   |                  |      |                 |
| 30 PURPOSE           |                   |                                      |           |         |                 |        |              |                   |                  |      |                 |

PRIMARY-TO ACQUIRE AND TRANSMIT PICTURES OF THE EARTH'S CLOUD COVER TO PROVIDE METEOROLOGISTS WITH DETAILED INFORMATION ON INDIVIDUAL CLOUD TYPES OVER SPECIFIC AREAS. THE FIRST SATELLITE IN THE TIROS OPERATIONAL SATELLITE (TOS) SYSTEM.

#### 31. PRINCIPLES OF OPERATION

THE ESSA 1 WIDE ANGLE TV CAMERA WAS IDENTICAL TO THOSE CARRIED ON ALL PREVIOUS TIROS MISSIONS. HOWEVER, THIS FLIGHT CAPRIED 2, IN A CARTWHEEL CONFIGURATION. (SIMILAR TO TIROS 9) THAT WERE MOUNTED ON THE SIDE OF THE SPACECRAFT AND CANTED 26 DEG TO EACH SIDE OF THE PLANE OF THE SATELLITES ROTATION. EACH CAMERA WAS AUTOMATICALLY TRIGGERED SO AS TO BE IN A PICTURE TAKING MODE ONLY WHEN VIEWING THE EARTH, ONCE EACH SPACECRAFT ROTATION (10 RPM). EACH CAMERA CONSISTS OF A 1/2-IN VIDICON TUBE AND A FOCAL-PLANE SHUTTER THAT PERMITS STORAGE OF STILL PICTURES ON THE TUBE SCREEN. AN ELECTRON BEAM CONVERTS THE STORED PICTURES INTO TV-TYPE ELECTRONIC SIGNALS, WHICH CAN ALSO PROCESS AND STORE UP TO 32 PICTURES ON MAGNETIC TAPE FOR LATER TRANSMISSION. THE CAMERA HAS A WIDE ANGLE (105 DEG) ELGEET F/1.5 LENS. THE CAMERA HAS A SHUTTER SPEED OF 1.5 MILLISEC AND A VIDEO-BANDWIDTH OF 62.5 KHZ. THE 500 LINE FRAME IS PROCESSED FOR STORAGE IN 2 SECS. A MINIMUM INTERVAL OF 10 SEC BETWEEN PICTURES IS REQUIRED FOR THE TARGET IMAGE TO BE ELECTRICALLY ERASED. TRANSMISSION OF THE REEL OF 32 PICTURES CAN BE ACCOMPLISHED IN 100 SEC BY A 2-WATT FM TRANSMITTER OPERATING AT A FREQUENCY OF 235 MHZ.

#### 32. PHENOMENA OBSERVED

CLOUD COVER AND THE EARTH'S SURFACE

33. MEASUREMENT RANGE

5 LEVELS OF GRAY 34. PRECISION AND ACCURACY

| 35. SPECTRAL F    | RANG  | E                |              |       |          |                  |       |        |           | 6. SP          | ECTR   | AL RE  | SOL  | UTIC        | )N      | 37. T | IME  | CON         | ISTA  | NT   |     |
|-------------------|-------|------------------|--------------|-------|----------|------------------|-------|--------|-----------|----------------|--------|--------|------|-------------|---------|-------|------|-------------|-------|------|-----|
| 0.4               |       | TO               |              | 0.    | 65       |                  | MI(   | CRO    | N I       | NA             |        |        |      |             |         |       |      |             |       |      |     |
| 38. FIELD OF V    | IEW   |                  |              |       |          |                  |       | JND S  |           |                |        |        |      |             |         |       |      |             |       |      | _   |
| 74.0              | BY    | 7                | 4 <b>.</b> 0 | [     | ) E G    | 65               | 0 1   | M      | ВҮ        | 650            | ) NN   | 1 FR   | DM   | 40          | 0 V     | IM /  | AL 1 | TIT         | UD    | E    | ]   |
| 40. ANGULAR RESC  |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      |     |
| 0.2               | DE    | G 1              | . 4          | NM    | ΡE       | PT               | V I   | IN     | E F       | RON            | 1 40   | ) O N  | M C  | LT          | ITU     | JDE   |      |             |       |      |     |
| 42. POINTING ACCU | RACY  | 43. P            | OINT         | ING   | RATE     |                  |       | 44. A  | LTIT      | UDE            |        |        |      |             | INA1    |       |      |             |       |      | ا ا |
|                   |       |                  |              |       |          |                  |       | ME     | D         | CIF            | CUL    | AR     | SI   | JN-         | SYN     | ICH   | F    | RET         | RO    | GRAD | ıΕ  |
| 46. SPECIAL RE    | QUIR  | EMEN             | ITS          |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      |     |
|                   |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      |     |
| 47. COMPONEN      | TS    |                  |              |       |          |                  |       |        |           |                |        |        |      |             | w-1     |       |      |             | -     |      | 1   |
| TV CAMER          | Α,    | TRA              | NSM          | IT    | LEB      | <b>,</b> T       | ΔP    | R      | ECO       | RDE            | R      |        |      |             |         |       |      |             |       |      |     |
| .48. WEIGHT       | 49. V | OLUN             | 1E           |       |          | 50.              | AVE   | RAGE F | OWER      | 51             | . STAN | DBY PO | WER  | <b>52</b> . | PEAK    |       |      |             | 3. MT | BF   | [   |
|                   |       |                  |              |       |          | $\mathbf{I}^{-}$ |       | 9 W    |           | - 1            |        |        |      |             | 9       | WA.   | TT:  | S           |       |      |     |
| 54. INTERFERENCE  | 55.   | MAGNE<br>NTERFER | TIC<br>ENCE  |       | 56. NI   | UCLEAR<br>RFEREN | CE    | 57     | THE       | RMAL<br>FERENC | E      | 58.    | SHIE | LDIN        | IG      |       |      |             |       | ,    |     |
|                   | S     | ENS              | ITI          | ٧E    |          |                  |       |        |           |                |        | MA     | GNE  | TI          | C S     | HI    | EL   | DIN         | G     | USEC | )   |
| 59. CALIBRATIO    | ON    |                  |              |       |          |                  | 60. D | ATA    | RECC      | VER            | Υ      |        |      | 61.         | FREQ    | UENC  | Y OF | OBSE        | RVA   | TION |     |
| NO IN-FL          | IGH   | T C              | AL I         | BRA   | TI       | NC               | D EL  | AY     | ED        | TEL            | EME    | TRY    |      | Ţρ          | AYS     | ID    | = (  | <u>DF</u>   | DR    | BIT  |     |
| 62. TELEMETRY     | Y REC | UIRE             | MEN          | TS    |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      |     |
| FULL REE          | L O   | F 3              | 2 P          | IC.   | TUR.     | ES               | CAN   | N B    | E R       | EAD            | 00     | JT I   | N I  | 00          | SE      | CO    | ND S | S U         | SI    | NG   |     |
| AN FM TR          | ANS   | MIT              | TER          | OF    | ER/      | AT I             | NG    | ΔT     | Д         | FRE            | QUE    | NCY    | OF   | 2           | 35      | MH    | Ζ.   |             |       |      |     |
|                   |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      |     |
| 63. ADVANTAG      | ES A  | ND LI            | MITA         | TION  | IS       |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      | ,   |
| BROAD SY          | NOP   | TIC              | VI           | EW    | ING      | 0 F              | Cl    | יטס    | D C       | OVE            | R P    | ATT    | ER   | 15.         | MO      | RE    | V.   | ALU         | AB    | LE   |     |
| DATA FOR          |       |                  |              |       |          | .,               |       |        |           |                |        |        |      |             |         |       |      | _           |       | _    | S   |
| 64. REFERENCE     |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      | 1   |
| 1)SIGNIF          | ICΔ   | NT               | ACH          | IF    | /EMI     | ENT              | S 1   | IN '   | SAT       | MF             | T 1    | 958    | -10  | 64          | . N     | IASA  | 4 9  | SP-         | 96    | ***  |     |
| 2)GOLDBE          |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      |     |
| NAUTICS,          |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      |     |
| TV CAMER          |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      |     |
| 4) INSTRU         |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      |     |
| AVAILABL          |       |                  |              |       |          |                  |       |        |           |                |        |        | -    |             |         |       |      |             |       |      |     |
| 65. HISTORICA     |       |                  |              | • • • | . , -, 1 | ,                |       |        |           | <u> J (</u>    |        |        |      | ., .,       | <u></u> |       |      | <del></del> |       |      | 7   |
|                   |       |                  | ·            |       |          | <del>;</del>     |       |        | - Feeting |                |        |        | -    |             |         |       |      | -           |       |      | ٦   |
|                   |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      | ᅥ   |
| }                 |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      |     |
| 1                 |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      |     |
| !                 |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      |     |
| l                 |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      |     |
|                   |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      |     |
|                   |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      | ļ   |
|                   |       | •                |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      |     |
|                   |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      |     |
|                   |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       | •    |     |
|                   |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      |     |
|                   |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      |     |
|                   |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      |     |
|                   |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      |     |
|                   |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      | I   |
|                   |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      |     |
|                   |       |                  | -            |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      |     |
|                   |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      |     |
|                   |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      |     |
|                   |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      | İ   |
|                   |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      | ľ   |
|                   |       |                  |              |       |          |                  |       |        |           |                |        |        |      |             |         |       |      |             |       |      | ı   |

|                          |                   |        | GREENBELI, MD.      | 20//1  |                   |               |                           |            |      |                 |
|--------------------------|-------------------|--------|---------------------|--------|-------------------|---------------|---------------------------|------------|------|-----------------|
| 1. TITLE                 |                   |        |                     |        |                   |               | 2. 4                      | CRONYM     | 3. E | XP NO           |
| VIDICON (                | CAMERA SYSTE      | Ч      |                     |        |                   |               | VC                        | SW         |      |                 |
| (TITLE CONT.             | )                 |        |                     |        |                   |               | 4. R                      | ESUME DATE |      | 5.<br>VERSION   |
| WIDE-ANG                 | LE LENS           |        |                     |        |                   |               | 0.0                       | 7/01/      |      | 0004            |
| 6. PRINCIPAL IN          | NVESTIGATOR       | 7. OR  | GANIZATION          |        |                   | 8. TI         | ELEPHO                    | NE         |      |                 |
| STROUD,                  | DARD SPACE        | FLT C  | ENTER               | 30     | 1-982             | 2-5042        | 2                         |            |      |                 |
| 9. CO-INVESTIGATOR 10. O |                   |        | GANIZATION          |        |                   | 11. T         | ELEPHO                    | NE         |      |                 |
|                          |                   |        |                     |        |                   |               |                           |            |      |                 |
| 12. CONTRACT<br>TYPE     | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX N   | IUMBER | 15. START<br>DATE | 16. C         | 16. COMPLETION 17. STATUS |            |      |                 |
|                          |                   |        |                     |        |                   |               |                           | POST       | FL   | IGHT            |
| 18. MONITOR              |                   | 19. AG | ENCY 20. PGM OFFICE |        |                   | 21. TELEPHONE |                           |            |      |                 |
| TEPPER,                  | M.                | NAS    | A HDQTES            | OA     | 'ERD              | 20            | 2-75                      | 5-2322     | 2    | _               |
| 22. VENDOR               |                   |        | 23. LOCATION        |        |                   |               | 24. FLIGHT<br>DATE        | 25. L      | EAD  | TIME            |
| RCA ASTR                 | O-ELECTRONIC      | S      | PRINCETON,          | NEW    | JERSE'            | Y             | 04/6                      | 50 NA      |      |                 |
| 26. INSTRUMEN            | T TYPE            |        |                     |        |                   |               |                           |            |      | 27.<br>SECURITY |
| IMAGER.                  | WIDE-ANGLE F.     | /1.5   | LOW-RESOLU          | TION   | 0.5-11            | <b>NCH</b>    | VIDI                      | CON        |      | UNC             |
| 28. APPLICATIO           | N .               |        | •                   |        | 29. SPACE         | CRAF          | T                         |            |      | ^               |
| MET                      |                   |        |                     |        | TIROS             | 1             |                           |            |      |                 |
| 30. PURPOSE              |                   |        |                     |        |                   |               |                           |            |      |                 |
|                          |                   |        |                     |        |                   |               |                           |            |      |                 |

PRIMARY-TO ACQUIRE AND TRANSMIT PICTURES OF THE EARTH'S CLOUD COVER TO PROVIDE METEOROLOGISTS WITH DETAILED INFORMATION ON INDIVIDUAL CLOUD TYPES OVER SPECIFIC AREAS.\*\*\*SECONDARY-TO TEST TV SENSOR IN SPACE.

#### 31. PRINCIPLES OF OPERATION

THIS CAMERA SUB-SYSTEM HAS FLOWN IN AN IDENTICAL CONFIGURATION ON TIROS 1-10 AND SIMILAR CONFIGURATION ON ESSA 1. ON TIROS 1-8. 10 THE CAMERAS WERE ALIGNED PARALLEL TO THE S/C SPIN AXIS AND EXTENDED THROUGH THE BASE PLATE. IT CONSISTS OF A 0.5 IN VIDICON TUBE AND A FOCAL-PLANE SHUTTER THAT PERMITS STORAGE OF STILL PICTURES ON THE TUBE SCREEN. AN ELECTRON BEAM CONVERTS THE STORED PICTURES INTO TELEVISION-TYPE ELECTRONIC SIGNALS WHICH CAN BE TRANSMITTED TO GROUND RECEIVERS ON COMMAND. THE SYSTEM CAN ALSO PROCESS AND STORE UP TO 32 PICTURES ON MAGNETIC TAPE FOR TRANSMISSION AT A LATER TIME. THE CAMERA HAS A WIDE ANGLE (125 DEG) ELGEET F/1.5 LENS PRODUCING A RESOLUTION OF 1.4 TO 2.0 NM. THE CAMERA HAS A SHUTTER SPEED OF 1.5 MILLISEC AND A VIDEO-BAND-WIDTH OF 62.5 KHZ. THE 500 LINE FRAME IS PROCESSED FOR STORAGE IN 2 SEC. A MINIMUM INTERVAL OF 10 SEC BETWEEN PICTURES IS RE-QUIRED FOR THE TARGET IMAGE TO BE ELECTRICALLY ERASED. THE CAM-ERA IS ALIGNED PARALLEL TO THE SATELLITES SPIN AXIS AND IS AUTO-MATICALLY TRIGGERED SO AS TO BE IN A PICTURE TAKING MODE ONLY WHEN DIRECTED TOWARD THE EARTH. TRANSMISSION OF THE ENTIRE REEL OF 32 PICTURES CAN BE ACCOMPLISHED IN 100 SEC BY A 2-WATT FM TRANSMITTER OPERATING AT A NOMINAL FREQUENCY OF 235 MHZ.

#### 32. PHENOMENA OBSERVED

CLOUD COVER AND THE EARTH'S SURFACE

#### 33. MEASUREMENT RANGE

5 LEVELS OF GRAY

| 25 SPECTRAL PANCE  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
| 35. SPECTRAL RANGE 36. SPECTRAL RESOLUTION 37, TIME CONSTANT   |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| 74.0 BY 74.0 DEG 740 NM BY 740 NM FROM 450 NM ALTITUDE  40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION  |  |  |  |  |  |  |
| 0.2 DEG 1.4 NM PER TV LINE FROM 450 NM ALTITUDE  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| 42. POINTING ACCURACY 43. POINTING RATE 44. ALTITUDE 45. INCLINATION  MED CIRCULAR MEDIUM POSIGRADE  |  |  |  |  |  |  |
| 46. SPECIAL REQUIREMENTS   |  |  |  |  |  |  |
| 40. SPECIAL REQUIREMENTS   |  |  |  |  |  |  |
| A7 COMPONENTO  |  |  |  |  |  |  |
| TV CAMERA. TRANSMITTER. TAPE RECORDER  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| The state of the s |  |  |  |  |  |  |
| 9 WATTS 9 WATTS  54. INTERFERENCE 56. INTERFERENCE 56. INTERFERENCE 57. INTERFERENCE 58. SHIELDING   |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| SENSITIVE MAGNETIC SHIELDING USED  59. CALIBRATION  60. DATA RECOVERY  61. FREQUENCY OF OBSERVATION  |  |  |  |  |  |  |
| The state of the s |  |  |  |  |  |  |
| NO IN-FLIGHT CALIBRATION DELAYED AND REALTIME DAYSIDE OF ORBIT   |  |  |  |  |  |  |
| 62. TELEMETRY REQUIREMENTS   |  |  |  |  |  |  |
| FULL REEL OF 32 PICTURES CAN BE READ OUT IN 100 SECONDS USING  |  |  |  |  |  |  |
| DATA FOR WEATHER ANALYSIS THAN FROM MED OR NARROW ANGLE CAMERAS  |  |  |  |  |  |  |
| 63. ADVANTAGES AND LIMITATIONS   |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| BROAD SYNOPTIC VIEWING OF CLOUD COVER PATTERNS. MORE VALUABLE  |  |  |  |  |  |  |
| DATA FOR WEATHER ANALYSIS THAN FROM MED. OR NARROW ANGLE CAMERAS  64. REFERENCES   |  |  |  |  |  |  |
| The second of th |  |  |  |  |  |  |
| 1)SIGNIFICANT ACHIEVEMENTS IN SAT MET 1958-1964. NASA SP-96.***  |  |  |  |  |  |  |
| 21GOLDBERG, E. A. AND LANDON, V.D.: KEY EQUIP FOR TIROS 1. ASTRO-  |  |  |  |  |  |  |
| NAUTICS, V.5, JUNE 1960.***3)MESNER, M.H. AND STANISZEWSKI, J.:  |  |  |  |  |  |  |
| TV CAMERAS FOR SPACE EXPLOR. ASTRONAUTICS, V.5, MAY 1960.***   |  |  |  |  |  |  |
| 4) INSTRUMENTS AND SPACECRAFT. NASA SP-3028, 1966. ***5) DATA  |  |  |  |  |  |  |
| AVAILABLE FROM NATIONAL WEATHER RECORDS CTR (ESSA), ASHEVILLE, NC.   |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| IDENTICAL CAMERA FLOWN ON TIROS 1-10 AND SIMILAR ON ESSA 1   |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
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| 1. TITLE             |                   |        |                   |         |                   |        | 2. /               | ACRONYM    | 3.   | EXP NO          |
|----------------------|-------------------|--------|-------------------|---------|-------------------|--------|--------------------|------------|------|-----------------|
| VIDICON (            | CAMERA SYSTEM     | 1      |                   |         |                   |        | VC                 | SW         |      |                 |
| (TITLE CONT.         | )                 |        |                   |         | *                 |        | 4. R               | ESUME DATE |      | 5.<br>VERSION   |
| WIDE-ANG             | LE LENS           |        |                   |         |                   |        | 0.5                | 1/01/      | 72   | 0005            |
| 6. PRINCIPAL II      | NVESTIGATOR       | 7. OR  | GANIZATION        |         |                   | 8. TE  | LEPHO              | NE         |      |                 |
| STAMPFL,             | R.A. (MGR)        | GOD    | DARD SPACE F      | LTC     | ENTER             | 301    | -982               | 2-504      | 2    |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION        |         |                   | 11. TE | ELEPHO             | NE         |      |                 |
|                      |                   |        |                   |         |                   |        |                    |            |      |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX N | UMBER   | 15. START<br>DATE | 16. CC | MPLETION<br>DATE   | 17. STA    | TUS  |                 |
|                      |                   |        |                   |         |                   |        |                    | POST       | FL   | _IGHT           |
| 18. MONITOR          |                   | 19. AG | ENCY              | 20. PGN | OFFICE            | 21. T  | ELEPHO             | ONE        |      |                 |
| TEPPER, 1            | М.                | NASA   | A HDQTRS          | OA/     | ERD               | 202    | 755                | -232       | 2    |                 |
| 22. VENDOR           |                   |        | 23. LOCATION      |         |                   |        | 24. FLIGHT<br>DATE | 25.        | LEAD | TIME            |
| RCA ASTRO            | D-ELECTRONICS     | 3      | PRINCETON,        | NEW     | JERSEY            | /      | 11/6               | AN O       |      |                 |
| 26. INSTRUMEN        | T TYPE            |        |                   |         |                   |        |                    |            |      | 27.<br>SECURITY |
| IMAGER, (            | 0.5-INCH WIDE     | -AN    | GLE F/1.5 LC      | W-RE    | SOLUTI            | ON     | VIDI               | CON        |      | UNC             |
| 28. APPLICATIO       | N                 |        |                   | 2       | 9. SPACE          | CRAF   | T                  |            |      |                 |
| MET                  |                   |        |                   |         | TIROS             | 2      |                    |            |      |                 |
|                      |                   |        |                   |         |                   |        |                    |            |      |                 |

#### 30. PURPOSE

PFIMARY-TO ACQUIRE AND TRANSMIT PICTURES OF THE EARTH'S CLOUD COVER TO PROVIDE METEOROLOGISTS WITH DETAILED INFORMATION ON INDIVIDUAL CLOUD TYPES OVER SPECIFIC AREAS.\*\*\*SECONDARY-TO TEST TV SENSOR IN SPACE.

#### 31. PRINCIPLES OF OPERATION

THIS CAMERA SUB-SYSTEM HAS FLOWN IDENTICALLY ON TIROS 1 THRU 10. A SIMILAR CONFIGURATION HAS FLOWN ON ESSA 1. ON TIROS 1 THRU 8 & 10 THE CAMERAS WERE ALIGNED PARALLEL TO THE S/C SPIN AXIS AND EXTENDED THROUGH THE BASE PLATE. IT CONSISTS OF A 1/2-IN VIDICON TUBE AND A FOCAL-PLANE SHUTTER THAT PERMITS STORAGE OF STILL PICTURES ON THE TUBE SCREEN. AN ELECTRON BEAM CONVERTS THE STORED PICTURES INTO TELEVISION-TYPE ELECTRONIC SIGNALS, WHICH CAN BE TRANSMITTED TO GROUND RECEIVERS ON COMMAND. THE SYSTEM CAN ALSO PROCESS AND STORE UP TO 32 PICTURES ON MAGNETIC TAPE FOR TRANSMISSION AT A LATER TIME. THE CAMERA HAS A WIDE ANGLE(105 DEG) ELGEET F/1.5 LENS PRODUCING A RESOLUTION OF 1.4 TO 2.0 NM. THE CAMERA HAS A SHUTTER SPEED OF 1.5 MILLISEC AND A VIDEO-BAND-WIDTH OF 62.5 KHZ. THE 500 LINE FRAME IS PROCESSED FOR STORAGE IN 2 SEC.A MINIMUM INTERVAL OF 10 SEC BETWEEN PICTURES IS RE-QUIRED FOR THE TARGET IMAGE TO BE ELECTRICALLY ERASED. THE CAMERA IS ALIGNED PARALLEL TO THE SPIN AXIS OF THE SATELLITE, AND IS TURNED ON BY COMMAND. TRANSMISSION OF THE ENTIRE REEL OF 32 PICTURES CAN BE ACCOMPLISHED IN 100 SECONDS BY A 2-WATT FM TRANSMITTER OPERATING AT A NOMINAL FREQUENCY OF 235 MHZ.

#### 32. PHENOMENA OBSERVED

CLOUD COVER AND THE EARTH'S SURFACE

#### 33. MEASUREMENT RANGE

7 TO 8 LEVELS OF GRAY

| 35. SPECTRAL RANGE                          | 36. SPECTRAL RESOLUTION 37. TIME CONSTANT  |
|---|--|
| 0.5 TO -0.65                                |  |
|   | 9. GROUND SWATH  |
|   | 650 NM BY 650 NM FROM 410 NM ALTITUDE  |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESO     |  |
| 0.2 DEG 1.4 NM PER                          | TV-LINE FROM 410 NM ALTITUDE   |
| 42. POINTING ACCURACY 43. POINTING RATE     | 44. ALTITUDE 45. INCLINATION   |
|   | MED CIRCULAR MEDIUM POSIGRADE  |
| 46. SPECIAL REQUIREMENTS                    |  |
|   |  |
| 47. COMPONENTS                              | A STATE OF THE PROPERTY OF THE |
| TV CAMERA, TRANSMITTER,                     | TAPE RECORDER  |
| 48. WEIGHT 49. VOLUME                       | 50. AVERAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF  |
| 7 LB  | 9 WATTS NONE 9 WATTS   |
| 54. INTERFERENCE 56. INTERFERENCE 56. INTER |  |
| SENSITIVE                                   | MAGNETIC SHIELDING USED  |
| 59. CALIBRATION                             | 60. DATA RECOVERY 61. FREQUENCY OF OBSERVATION   |
|   | DELAYED AND REALTIME DAYSIDE OF ORBIT  |
| 62. TELEMETRY REQUIREMENTS                  |  |
| FULL REEL OF 32 PICTURE                     | S CAN BE READ OUT IN 100 SECONDS USING   |
| AN FM TRANSMITTER OPERA                     | TING AT FREQUENCY OF 235 MHZ.  |
|   |  |
| 63. ADVANTAGES AND LIMITATIONS              |  |
| BROAD SYNOPTIC VIEWING                      | OF CLOUD COVER PATTERNS. MORE VALUABLE   |
|   | IS THAN FROM MED OR NARROW ANGLE CAMERAS   |
| 64" REFERENCES                              |  |
| 1) SIGNIFICANT ACHIEVEME                    | NTS IN SAT MET 1958-1964. NASA SP-96.***   |
|   | NDON, V.D.: KEY EQUIP FOR TIROS 1. ASTRO-  |
|   | ****3)MESNER,M.H. AND STANISZEWSKI, J.:  |
|   | PLOR. ASTRONAUTICS, V.5, MAY 1960.***  |
|   | ECRAFT. NASA SP-3028, 1966. ***5) DATA   |
|   | WEATHER RECORDS CTR (ESSA), ASHEVILLE, NC.   |
| 65. HISTORICAL REMARKS                      | HEATHER RECORDS CIR TESSAJJASHEVILLEJNG  |
|   | ON TIROS 1-10; SIMILAR CAMERA DN ESSA 1.   |
| IDENTICAL CAMERA PLUMN                      | JN TINUS 1-10, SIMILAR CAMERA UN ESSA 1.   |
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| 1. TITLE               |                   |        |                                       |         |          |              | 2. 4                                    | ACRONYM    | 3.  | EXP NO                  |  |
|------------------------|-------------------|--------|---------------------------------------|---------|----------|--------------|---|------------|-----|-------------------------|--|
| VIDICON C              | CAMERA SYSTEM     | 1      |                                       |         |          |              | VC                                      | SW         |     |                         |  |
| (TITLE CONT.           | )                 |        |                                       |         |          |              | 4. RI                                   | ESUME DATE |     | 5.<br>VERSION           |  |
| WIDE-ANGL              | LE LENS           |        |                                       |         |          |              | <u>G</u> 9                              | //01/      | 12  | 0005                    |  |
| 6. PRINCIPAL IN        | NVESTIGATOR       |        | GANIZATION                            |         |          |              | ELEPHO                                  | NE         |     |                         |  |
| RADOS, R.M. (MGR.) GOD |                   |        | DARD SPACE FL                         | TCI     | ENTER    | 301          | l-982                                   | 982-5042   |     |                         |  |
| 9. CO-INVESTIGATOR     |                   | 10. OR | GANIZATION                            |         |          | 11. T        | ELEPHO                                  | NE         |     |                         |  |
|                        |                   |        |                                       |         |          |              |   |            |     |                         |  |
| 12. CONTRACT<br>TYPE   | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NUMBER 15. START DATE |         |          | 16. C        | 16. COMPLETION 17. STATUS               |            |     |                         |  |
|                        |                   |        |                                       |         |          |              |   | POST       | FL  | IGHT                    |  |
| 18. MONITOR            |                   | 19. AG | ENCY                                  | 20. PGM | OFFICE   | 21. T        | ELEPHO                                  | ONE        |     | _                       |  |
| TEPPER, N              | <b>У</b> .        | NASA   | HDQTRS                                | OA/     | ERD      | 202-755-2322 |   |            |     |                         |  |
| 22. VENDOR             | <del></del>       |        | 23. LOCATION                          |         |          |              | 24. FLIGHT<br>DATE                      | 25. L      | EAC | TIME                    |  |
| RCA ASTRO              | D-ELECTRONICS     | 3      | PRINCETON, N                          | IEW .   | JERSE    | Y            | 07/6                                    | 1 NA       |     |                         |  |
| 26. INSTRUMEN          |                   |        |                                       |         |          |              |   |            |     | 27.<br><b>SECURIT</b> Y |  |
| IMAGER, (              | 3.5-INCH WIDE     | -ANO   | GLE F/1.5 LOW                         | N RE    | SOLUT    | LON          | VIDI                                    | CON        |     | UNE                     |  |
| 28. APPLICATIO         |                   |        |                                       |         | 9. SPACE |              |   |            |     |                         |  |
| MET                    |                   |        |                                       |         | TIROS    | 3            |   |            |     |                         |  |
| 20 DIIDPOSE            |                   |        |                                       |         |          |              | *************************************** |            |     |                         |  |

PRIMARY-TO ACQUIRE AND TRANSMIT PICTURES OF THE EARTH'S CLOUD COVER TO PROVIDE METEOROLOGISTS WITH DETAILED INFORMATION ON INDIVIDUAL CLOUD TYPES OVER SPECIFIC AREAS.\*\*\*SECONDARY-TO TEST TV SENSOR IN SPACE.

#### 31. PRINCIPLES OF OPERATION

THIS CAMERA SUB-SYSTEM HAS FLOWN IN AN IDENTICAL CONFIGURATION ON TIROS 1-10 AND SIMILAR CONFIGURATION ON ESSA 1. HOWEVER ON THIS FLIGHT (TIROS 3) 2 WIDE ANGLE CAMERAS WERE USED. IT CONSISTS OF A 1/2 IN VIDICON TUBE AND A FOCAL-PLANE SHUTTER THAT PERMITS STORAGE OF STILL PICTURES ON THE TUBE SCREEN. AN ELECTRON BEAM CONVERTS THE STORED PICTURES INTO TELEVISION-TYPE ELECTRONIC SIGNALS, WHICH CAN BE TRANSMITTED TO GROUND RECEIVERS ON COMMAND. THE SYSTEM CAN ALSO PROCESS AND STORE UP TO 32 PICTURES ON MAG-NETIC TAPE FOR TRANSMISSION AT A LATER TIME. THE CAMERA HAS A WIDE ANGLE(105 DEG) ELGEET F/1.5 LENS PRODUCING A RESOLUTION OF 1.5 TO 2.0 NM. THE CAMERA HAS A SHUTTER SPEED OF 1.5 MILLISEC AND A VIDEO-BANDWIDTH OF 62.5 KHZ. THE 500 LINE FRAME IS PRO-CESSED FOR STORAGE IN 2 SEC. A MINIMUM INTERVAL OF 10 SEC BE-TWEEN PICTURES IS REQUIRED FOR THE TARGET IMAGE TO BE ELECTRI-CALLY EPASED. THE CAMERA IS ALIGNED PARALLEL TO THE SATELLITE'S SPIN AXIS AND IS AUTOMATICALLY TRIGGERED SO AS TO BE IN A PIC-TURE TAKING MODE ONLY WHEN DIRECTED TOWARD THE EARTH. TRANSMIS-SION OF THE ENTIRE REEL OF 32 PICTURES CAN BE ACCOMPLISHED IN 100 SEC BY A 2-WATT FM TRANSMITTER OPERATING AT NOMINAL FRE-QUENCY OF 235 MHZ.

#### **32. PHENOMENA OBSERVED**

CLOUD COVER AND THE EARTH'S SURFACE

#### 33. MEASUREMENT RANGE

TO 8 LEVELS OF GRAY

| 35. SPECTRAL RANGE                            |  | 37. TIME CONSTANT    |
|---|--|----------------------|
| 0.5 TO 0.65                                   | MICRONS NA   | ·                    |
| 38. FIELD OF VIEW                             | 39. GROUND SWATH   |                      |
| 74.0 BY 74.0 DEG                              | 750 NM 750 NM FROM 475 NM  | ALTITUDE             |
| 40. ANGULAR RESOLUTION 41, SPATIAL RESOLUTION |  |                      |
|   | TV-LINE FROM 475 NM ALTITU   | ne l                 |
| 42. POINTING ACCURACY 43. POINTING RATE       |  |                      |
| 42. FORTING ACCORACY 43. FORTING HATE         | MED CIRCULAR MEDIUM  |                      |
|   | MED CIRCULAR   MEDIUM  | PUSTGRADE            |
| 46. SPECIAL REQUIREMENTS                      |  |                      |
|   |  |                      |
| 47. COMPONENTS                                |  |                      |
| TV CAMERA, TRANSMITTER                        | , TAPE RECORDER  |                      |
| 48. WEIGHT 49. VOLUME                         | 50. AVERAGE POWER 51. STANDBY POWER 52. PEAR   | POWER 53. MTBF       |
| 7 LB  | 9 WATTS NONE 9   | WATTS                |
| 54. INTERFERENCE 55. MAGNETIC 56. INTER       | CLEAR 57. THERMAL 58. SHIELDING  |                      |
| SENSITIVE                                     | The state of the s | SHIELDING USED       |
| 59. CALIBRATION                               |  | UENCY OF OBSERVATION |
|   | ON DELAYED AND REALTIME DAY  |                      |
|   | UN DELATED AND REALITME DAT  | THE OF UKUII         |
| 62. TELEMETRY REQUIREMENTS                    | CO CAN DE DEAC OUT TO LOCAL  | 560406 465546        |
| l .   | ES CAN BE READ OUT IN 100 S  | l l                  |
| AN EM TRANSMITTER OPER                        | ATING AT FREQUENCY OF 235 M  | HZ•                  |
|   |  |                      |
| 63. ADVANTAGES AND LIMITATIONS                |  |                      |
| BROAD SYNOPTIC VIEWING                        | OF CLOUD COVER PATTERNS. M   | ORE VALUABLE         |
| l .   | SIS THAN FROM MED OR NARROW  |                      |
| 64. REFERENCES                                |  |                      |
| 1 ACTUAL CONTENEM                             | ENTS IN SAT MET 1958-1964.   | MACA CD-06 ***       |
|   |  |                      |
| , · · · · · · · · · · · · · · · · · · ·       | ANDON, V.D.: KEY EQUIP FOR   | 4                    |
|   | O.***3)MESNER, M.H. AND STA  |                      |
|   | XPLOR. ASTRONAUTICS, V.5, M  |                      |
| 4) INSTRUMENTS AND SPA                        | CECRAFT. NASA SP-3028, 1966  | • ***5) DATA         |
| AVAILABLE FROM NATIONAL                       | L WEATHER RECORDS CTR (ESSA  | ), ASHEVILLE, NC.    |
| 65. HISTORICAL REMARKS                        |  |                      |
| IDENTICAL CAMERA FLOWN                        | ON TIROS 1-10; SIMILAR CAM   | ERA ON ESSA 1        |
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|----------------------|-------------------|--------------------------------------|------------------|--------|-------------------|---------------------------|--------------------|--------------------|------|-----------------|
| 1. TITLE             |                   |                                      |                  |        |                   |                           | 2. /               | ACRONYM            | 3. 1 | EXP NO          |
| VIDICON              | CAMERA SYSTE      | М                                    |                  |        |                   |                           | V                  | CSW                |      |                 |
| (TITLE CONT.         | )                 |                                      |                  |        |                   |                           | 4. R               | ESUME DATE         |      | 5.<br>VERSION   |
| WIDE-ANG             | LE LENS           |                                      |                  |        |                   |                           | 0.0                | 9/01/              | 72   | 0005            |
| 6. PRINCIPAL IN      | NVESTIGATOR       | 7. ORGANIZATION 8. TELEF             |                  |        |                   | ELEPHO                    | NE                 |                    |      |                 |
| RADOS, R             | .M. (MGR.)        | GOD                                  | DARD SPACE FL    | TC     | ENTER             | 30                        | 1-982              | 2-504              | 2    |                 |
| 9. CO-INVESTIGATOR   |                   | 10. OR                               | GANIZATION       |        |                   | 11. T                     | ELEPHO             | NE.                |      |                 |
|                      |                   |                                      |                  |        |                   |                           |                    |                    |      |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | BER 14. FLASH INDEX NUMBER 15. START |                  |        | 16. <sup>Cd</sup> | 16. COMPLETION 17. STATUS |                    |                    |      |                 |
|                      |                   |                                      |                  |        |                   |                           |                    | POST               | FL   | IGHT            |
| 18. MONITOR          |                   | 19. AGENCY 20. PGM OF                |                  | OFFICE | 21. TELEPHONE     |                           |                    |                    |      |                 |
| TEPPER,              | м.                | NAS                                  | A HDQTRS         | OA/    | ERD               | 20.                       | 2-75!              | 5 <del>-</del> 232 | 2    |                 |
| 22. VENDOR           |                   |                                      | 23. LOCATION     |        |                   |                           | 24. FLIGHT<br>DATE | 25. L              | EAD  | TIME            |
| RCA ASTR             | O-ELECTRONIC:     | S                                    | PRINCETON, N     | IEW .  | JERSE'            | Υ                         | 02/6               | 62 NA              |      |                 |
| 26. INSTRUMEN        | T TYPE            |                                      |                  |        |                   |                           |                    |                    |      | 27.<br>SECURITY |
| IMAGER,              | 0.5-INCH WID      | E-AN                                 | GLE F/1.5 LOV    | N-RE   | SOLUT             | ION                       | VID                | ICON               |      | UNC             |
| 28. APPLICATIO       | N                 |                                      |                  | 2      | 9. SPACE          | CRAF                      | T                  |                    |      |                 |
| MET                  |                   |                                      |                  |        | TIROS             | 4.                        |                    |                    |      |                 |
| 30. PURPOSE          |                   |                                      |                  |        |                   |                           |                    |                    |      |                 |
| ~ ~ • • • • • • •    | TO 4501170 41     | 110 · F                              | CANCHIT OFCT     | 10 5 6 | OF T              |                           | CADT               | 11 6 6             |      | 10              |

PRIMARY-TO ACQUIRE AND TRANSMIT PICTURES OF THE EARTH'S CLOUD COVER TO PROVIDE METEOROLOGISTS WITH DETAILED INFORMATION ON INDIVIDUAL CLOUD TYPES OVER SPECIFIC AREAS.\*\*\*SECONDARY-TO TEST TV SENSOR IN SPACE.

#### 31. PRINCIPLES OF OPERATION

THIS CAMERA SUB-SYSTEM HAS FLOWN IN AN IDENTICAL CONFIGURATION ON TIROS 1-10 AND SIMILAR CONFIGURATION ON ESSA 1. ON TIROS 1-8, 10 THE CAMERAS WERE ALIGNED PARALLEL TO THE S/C SPIN AXIS AND EXTENDED THROUGH THE BASE PLATE. IT CONSISTS OF A 1/2-IN VIDICON TUBE AND A FOCAL-PLANE SHUTTER THAT PERMITS STORAGE OF STILL PICTURES ON THE TUBE SCREEN. AN ELECTRON BEAM CONVERTS THE STORED PICTURES INTO TELEVISION-TYPE ELECTRONIC SIGNALS, WHICH CAN BE TRANSMITTED TO GROUND RECEIVERS ON COMMAND. THE SYSTEM CAN ALSO PROCESS AND STORE UP TO 32 PICTURES ON MAGNETIC TAPE FOR TRANSMISSION AT A LATER TIME. THE CAMERA HAS A WIDE ANGLE (105 DEG) ELGEET F/1.5 LENS PRODUCING A RESOLUTION OF 1.4 TO 2.0 NM. THE CAMERA HAS A SHUTTER SPEED OF 1.5 MILLISEC AND A VIDEO-BAND-WIDTH OF 62.5 KHZ. THE 500 LINE FRAME IS PROCESSED FOR STORAGE IN 2 SEC. A MINIMUM INTERVAL OF 10 SEC BETWEEN PICTURES IS RE-QUIRED FOR THE TARGET IMAGE TO BE ELECTRICALLY ERASED.THE CAMERA IS ALIGNED PARALLEL TO THE SATELLITE'S SPIN AXIS AND IS AUTO-MATICALLY TRIGGERED SO AS TO BE IN A PICTURE TAKING MODE ONLY WHEN DIRECTED TOWARD THE EARTH. TRANSMISSION OF THE ENTIRE REEL OF 32 PICTURES CAN BE ACCOMPLISHED IN 100 SEC BY A 2-WATT FM TRANSMITTER OPERATING AT A NOMINAL FREQUENCY OF 235 MHZ.

#### 32. PHENOMENA OBSERVED

CLOUD COVER AND THE EARTH'S SURFACE

#### 33. MEASUREMENT RANGE

7 TO 8 LEVELS OF GRAY

|  | ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,                               |                     |                                       |  |  |  |  |  |  |
|--|--|---------------------|---------------------------------------|--|--|--|--|--|--|
| 35. SPECTRAL RANGE                                     |  | L RESOLUTION        | 37. TIME CONSTANT                     |  |  |  |  |  |  |
|  | CRONS NA   |                     | 1                                     |  |  |  |  |  |  |
| 38. FIELD OF VIEW 39. GROUND SWATH                     |  |                     |                                       |  |  |  |  |  |  |
|  | NM BY 750 NM   | FROM 475            | NM ALTITUDE                           |  |  |  |  |  |  |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION          |  |                     |                                       |  |  |  |  |  |  |
| C.2 DEG 1.5 NM PER TV-                                 | 0.2 DEG 1.5 NM PER TV-LINE FROM 475 NM ALTITUDE                      |                     |                                       |  |  |  |  |  |  |
| 42. POINTING ACCURACY 43. POINTING RATE                | 42. POINTING ACCURACY 43. POINTING RATE 44. ALTITUDE 45. INCLINATION |                     |                                       |  |  |  |  |  |  |
|  | MED CIRCULA  | R MEDIUM            | POSIGRADE                             |  |  |  |  |  |  |
| 46. SPECIAL REQUIREMENTS                               |  |                     |                                       |  |  |  |  |  |  |
|  |  |                     |                                       |  |  |  |  |  |  |
| 47. COMPONENTS   |  |                     |                                       |  |  |  |  |  |  |
| TV CAMERA, TRANSMITTER, TAP                            | E RECORDER   |                     |                                       |  |  |  |  |  |  |
| 48. WEIGHT 49. VOLUME 50. AV                           | ERAGE POWER 51. STAND  | BY POWER 52. PEA    | K POWER 53. MTBF                      |  |  |  |  |  |  |
| 7 LB   | 9 WATTS NONE   | 9                   | WATTS                                 |  |  |  |  |  |  |
| S4. INTERFERENCE S5. MAGNETIC S6. NUCLEAR INTERFERENCE | 57. THERMAL<br>INTERFERENCE  | 58. SHIELDING       |                                       |  |  |  |  |  |  |
| SENSITIVE  |  |                     | SHIELDING USED                        |  |  |  |  |  |  |
|  | DATA RECOVERY  |                     | QUENCY OF OBSERVATION                 |  |  |  |  |  |  |
| NO IN-FLIGHT CALIBRATION DE                            |  | ALTIME DAY          | SIDE OF ORBIT                         |  |  |  |  |  |  |
| 62. TELEMETRY REQUIREMENTS                             | COLUMN TOUR CAR  |                     | w. w. w.                              |  |  |  |  |  |  |
| FULL REEL OF 32 PICTURES CA                            | N BE READ OUT  | TN 100 S            | ECONDS LISTNG                         |  |  |  |  |  |  |
| IAN EM TRANSMITTER OPERATING                           | <del>-</del>   | · • · · · · · · · · |                                       |  |  |  |  |  |  |
| AND THE TRANSPORTING OF ENAMING                        | AT THE WOLNUT  | Ot EJJ M            |                                       |  |  |  |  |  |  |
| 63. ADVANTAGES AND LIMITATIONS                         |  |                     |                                       |  |  |  |  |  |  |
| BROAD SYNOPTIC VIEWING OF C                            | I OUD COVED DA   | TTEDUC M            | ODE VALUADIE                          |  |  |  |  |  |  |
|  |  |                     |                                       |  |  |  |  |  |  |
| DATA FOR WEATHER ANALYSIS T                            | HAN FRUM MED   | UK NAKKUW           | ANGLE CAMERAS                         |  |  |  |  |  |  |
|  | THE CAT MET 10   | 250 1077            | NA CA CO OC                           |  |  |  |  |  |  |
| 1)SIGNIFICANT ACHIEVEMENTS                             |  |                     | · · · · · · · · · · · · · · · · · · · |  |  |  |  |  |  |
| 2)GOLDBERG, E.A. AND LANDON                            | •  |                     |                                       |  |  |  |  |  |  |
| NAUTICS, V.5, JUNE 1960.***                            |  |                     |                                       |  |  |  |  |  |  |
| TV CAMERAS FOR SPACE EXPLOR                            |  |                     |                                       |  |  |  |  |  |  |
| 4) INSTRUMENTS AND SPACECRA                            |  |                     | · ·                                   |  |  |  |  |  |  |
| AVAILABLE FROM NATIONAL WEA                            | THER RECORDS   | CTR (ESSA           | ),ASHEVILLE,NC.                       |  |  |  |  |  |  |
| 65. HISTORICAL REMARKS                                 |  |                     |                                       |  |  |  |  |  |  |
| IDENTICAL CAMERA FLOWN ON T                            | IROS 1-10. SI  | MILAR CAM           | ERA ON ESSA 1.                        |  |  |  |  |  |  |
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|                                |                   |                    | GREENBELT, MD. 2          | 20771 |                   |               |                   |                   |     |                 |
|--------------------------------|-------------------|--------------------|---------------------------|-------|-------------------|---------------|-------------------|-------------------|-----|-----------------|
| 1. TITLE                       | 1                 |                    |                           |       |                   |               | 2. /              | CRONYM            | 3.  | EXP NO          |
| VIDICON                        | CAMERA SYSTE      | М                  |                           |       |                   |               | V                 | CSW               |     |                 |
| (TITLE CONT.                   | )                 |                    |                           |       |                   |               | 4. R              | ESUME DATE        |     | 5.<br>VERSION   |
| wIDE-ANG                       | LE LENS           |                    |                           |       |                   |               | 0.0               | 9/01/             | 72  | 0005            |
| 6. PRINCIPAL INVESTIGATOR 7. 0 |                   |                    | GANIZATION                |       |                   | 8. T          | ELEPHO            | NE                |     |                 |
| RADOS, R.M. (MGP.) G           |                   |                    | DARD SPACE FI             | LT C  | ENTER             | 30            | 1-98              | 982-5042          |     |                 |
| 9. CO-INVESTIGATOR 1           |                   |                    | GANIZATION                |       |                   | 11. TELEPHONE |                   |                   |     |                 |
|                                |                   |                    |                           |       | 15. START<br>DATE |               |                   |                   |     |                 |
| 12. CONTRACT<br>TYPE           | 13. CONTRACT NUMB | ER                 | ER 14. FLASH INDEX NUMBER |       |                   | 16. C         | OMPLETION<br>DATE | TETION 17. STATUS |     |                 |
|                                |                   | - 1                |                           |       |                   |               |                   | POST              | FI  | LIGHT           |
| 18. MONITOR                    |                   | 19. AGENCY 20. PGM |                           |       | OFFICE            | 21. TELEPHONE |                   |                   |     |                 |
| TEPPER,                        | М.                | NAS.               | NASA HDQTPS DA/E          |       |                   | 202-755-2322  |                   |                   |     |                 |
| 22. VENDOR                     |                   |                    | 23. LOCATION              |       |                   |               | 24. FLIGH<br>DATE | 25. 1             | EAC | TIME            |
| RCA ASTR                       | O-ELECTRONIC      | S                  | PRINCETON, !              | NEW   | JERSE             | Υ             | 06/               | 52 NA             |     |                 |
| 26. INSTRUMEN                  | IT TYPE           |                    |                           |       |                   |               |                   |                   |     | 27.<br>SECURITY |
| IMAGER.                        | 0.5-INCH WID      | E-AN               | GLE F/1.5 LO              | W-RE  | SOLUT             | ION           | DIV               | ICON              |     | UNC             |
| 28. APPLICATIO                 | N .               |                    |                           | [2    | 29. SPACE         | CRAF          | T                 |                   |     |                 |
| MET                            |                   |                    |                           |       | TIROS             | 5             |                   |                   |     |                 |
| 30. PURPOSE                    |                   |                    |                           |       |                   |               |                   |                   |     |                 |

PRIMARY-TO ACQUIRE AND TRANSMIT PICTURES OF THE EARTH'S CLOUD COVER TO PROVIDE METEOROLOGISTS WITH DETAILED INFORMATION ON INDIVIDUAL CLOUD TYPES OVER SPECIFIC AREAS.\*\*\*SECONDARY-TO TEST TV SENSOR IN SPACE.

#### 31. PRINCIPLES OF OPERATION

THIS CAMERA SUB-SYSTEM HAS FLOWN IN AN IDENTICAL CONFIGURATION UN TIROS 1-12 AND SIMILAR CONFIGURATION ON ESSA 1. ON TIROS 1-8. 10 THE CAMERAS WERE ALIGNED PARALLEL TO THE S/C SPIN AXIS AND EXTENDED THROUGH THE BASE PLATE. IT CONSISTS OF A 1/2-IN VIDICON TUBE AND A FOCAL-PLANE SHUTTER THAT PERMITS STORAGE OF STILL PICTURES ON THE TUBE SCREEN. AN ELECTRON BEAM CONVERTS THE STORED PICTURES INTO TELEVISION-TYPE ELECTRONIC SIGNALS, WHICH CAN BE TRANSMITTED TO GROUND RECEIVERS ON COMMAND. THE SYSTEM CAN ALSO PROCESS AND STORE UP TO 32 PICTURES ON MAGNETIC TAPE FOR TRANS-MISSION AT A LATER TIME. THE CAMERA HAS A WIDE ANGLE (105 DEG) ELGEET F/1.5 LENS PRODUCING A RESOLUTION OF 1.4 TO 2.0 NM. THE CAMERA HAS A SHUTTER SPEED OF 1.5 MILLISEC AND A VIDEO-BANDWIDTH OF 62.5 KHZ. THE 500 LINE FRAME IS PROCESSED FOR STORAGE IN 2 SEC. A MINIMUM INTERVAL OF 10 SEC BETWEEN PICTURES IS REQUIRED FOR THE TARGET IMAGE TO BE ELECTRICALLY ERASED. THE CAMERA IS A-LIGNED PARALLEL TO THE SATELLITE'S SPIN AXIS AND IS AUTOMATICAL-LY TRIGGERED SO AS TO BE IN A PICTURE TAKING MODE ONLY WHEN DI-RECTED TOWARD THE EARTH. TRANSMISSION OF THE ENTIRE REEL OF 32 PICTURES CAN BE ACCOMPLISHED IN 100 SEC BY A 2-WATT FM TRANS-MITTER OPERATING AT A NOMINAL FREQUENCY OF 235 MHZ.

#### 32. PHENOMENA OBSERVED

CLOUD COVER AND THE EARTH'S SURFACE

#### 33. MEASUREMENT RANGE

7 TO 8 LEVELS OF GRAY

| 35. SPECTRAL RANGE                           | 36. SPECTRAL RESOLUTION 37. TIME CONSTANT  |  |  |  |  |  |
|--|--|--|--|--|--|--|
| 0.5 TO 0.65                                  |  |  |  |  |  |  |
| 38. FIELD OF VIEW                            | 39. GROUND SWATH   |  |  |  |  |  |
|  | 740 NM BY 740 NM FROM 450 NM ALTITUDE  |  |  |  |  |  |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES       | SOLUTION   |  |  |  |  |  |
|  | R TV-LINE FROM 450 NM ALTITUDE   |  |  |  |  |  |
| 42. POINTING ACCURACY 43. POINTING RAT       |  |  |  |  |  |  |
|  | MED CIRCULAR MEDIUM POSIGRADE  |  |  |  |  |  |
| 46. SPECIAL REQUIREMENTS                     |  |  |  |  |  |  |
| 47.0040045450                                |  |  |  |  |  |  |
| 47. COMPONENTS                               | TARE RECORDER  |  |  |  |  |  |
| TV CAMERA, TRANSMITTER 48. WEIGHT 49. VOLUME |  |  |  |  |  |  |
| 7 LB   | 50. AVERAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF  9 WATTS NONE 9 WATTS  |  |  |  |  |  |
|  | MUCLEAR ST. INTERMAL ST. INTERPRETED ST. INTER |  |  |  |  |  |
| SENSITIVE                                    | MAGNETIC SHIELDING USED  |  |  |  |  |  |
| 59. CALIBRATION                              | 60. DATA RECOVERY 61. FREQUENCY OF OBSERVATION   |  |  |  |  |  |
|  | ON DELAYED AND REALTIME DAYSIDE OF ORBIT   |  |  |  |  |  |
| 62. TELEMETRY REQUIREMENTS                   | ON DESIGNED MIS MERELIAND DATISTON OF UNDIT  |  |  |  |  |  |
|  | ES CAN BE READ OUT IN 100 SECONDS USING  |  |  |  |  |  |
|  | ATING AT FREQUENCY OF 235 MHZ.   |  |  |  |  |  |
|  |  |  |  |  |  |  |
| 63. ADVANTAGES AND LIMITATIONS               |  |  |  |  |  |  |
| BROAD SYNOPTIC VIEWING                       | OF CLOUD COVER PATTERNS. MORE VALUABLE   |  |  |  |  |  |
|  | SIS THAN FROM MED OR NARROW ANGLE CAMERAS.   |  |  |  |  |  |
| 64. REFERENCES                               |  |  |  |  |  |  |
|  | IENTS IN SAT MET 1958-1964. NASA SP-96.***   |  |  |  |  |  |
|  | ANDON, V.D.: KEY EQUIP FOR TIRDS 1. ASTRO-   |  |  |  |  |  |
|  | 0. ** * 3) MESNER, M.H. AND STANISZEWSKI, J.:  |  |  |  |  |  |
|  | XPLOR. ASTRONAUTICS, V.5, MAY 1960.***   |  |  |  |  |  |
|  | CECRAFT. NASA SP-3028, 1966. ***5) DATA  |  |  |  |  |  |
|  | L WEATHER RECORDS CTR (ESSA), ASHEVILLE, NC.   |  |  |  |  |  |
| 65. HISTORICAL CAMERA EL CHA                 | LON TIPOC 1 10 CINTA AS CANCOL OF COC.   |  |  |  |  |  |
| IDENTICAL CAMERA FLUWN                       | ON TIROS 1-10. SIMILAR CAMERA ON ESSA 1.   |  |  |  |  |  |
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### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER

GREENBELT, MD. 20771

| 1. TITLE             | 1. TITLE          |        |                           |                           |           |                   |                    |           | 3. EXP NO       |  |
|----------------------|-------------------|--------|---------------------------|---------------------------|-----------|-------------------|--------------------|-----------|-----------------|--|
| VIDICON              | CAMERA SYSTE      | М      |                           |                           |           |                   | VC                 | SW        |                 |  |
| (TITLE CONT.         |                   |        |                           |                           |           |                   | 4. RE              | SUME DATE | 5.<br>VERSION   |  |
| WIDE-ANG             | LE LENS           |        |                           |                           | -         |                   | 09/01/72 0005      |           |                 |  |
|                      |                   |        | GANIZATION                |                           |           | 8. TE             | LEPHO              | NE        |                 |  |
| RADOS, R.M. (MGR.)   |                   |        | DARD SPACE FL             | _T_C                      | ENTER     | 30                | 1-982              | 2-5042    | 2               |  |
|                      |                   |        | GANIZATION                |                           |           | 11. T             | ELEPHO             | NE        |                 |  |
|                      |                   |        |                           |                           |           |                   |                    |           |                 |  |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU        | 4. FLASH INDEX NUMBER 15. |           | 16. COMPLETION 17 |                    | 17. STAT  | '. STATUS       |  |
|                      |                   |        |                           |                           |           |                   |                    | POST      | FLIGHT          |  |
| 18. MONITOR          |                   | 19. AG | 19. AGENCY 20. PGM OFFICE |                           |           | 21. TELEPHONE     |                    |           |                 |  |
| TEPPER.              | M.                | NAS    | NASA HDQTRS DA/ERD        |                           |           | 202-755-2322      |                    |           | 2               |  |
| 22. VENDOR           |                   |        | 23. LOCATION              |                           |           |                   | 24. FLIGHT<br>DATE | 25. L     | EAD TIME        |  |
| RCA ASTR             | O-ELECTRONIC      | S      | PRINCETON, N              | 1EW                       | JERSE     | Y                 | 09/6               | 52 NA     |                 |  |
| 26. INSTRUMEN        |                   |        |                           |                           |           |                   |                    |           | 27.<br>SECURITY |  |
| IMAGER,              | 0.5-INCH WID      | E-AN   | GLE F/1.5 LO              | N-RE                      | SOLUT     | ION               | VIDI               | CON       | ^               |  |
| 28. APPLICATIO       | N                 |        |                           |                           | 29. SPACE | CRAF              | T                  |           |                 |  |
| MET                  |                   |        |                           |                           | TIROS     | 6                 |                    |           |                 |  |
| 30. PURPOSE          |                   |        | s .                       |                           |           |                   |                    |           |                 |  |
|                      |                   |        |                           |                           |           |                   |                    |           |                 |  |

PRIMARY-TO ACQUIRE AND TRANSMIT PICTURES OF THE EARTH'S CLOUD COVER TO PROVIDE METEOROLOGISTS WITH DETAILED INFORMATION ON INDIVIDUAL CLOUD TYPES OVER SPECIFIC AREAS. \*\*\* SECONDARY-TO TEST TV SENSOR IN SPACE.

#### 31. PRINCIPLES OF OPERATION

THIS CAMERA SUB-SYSTEM HAS FLOWN IN AN IDENTICAL CONFIGURATION ON TIROS 1-10 AND SIMILAR CONFIGURATION ON ESSA 1. ON TIROS 1-8, 10 THE CAMERAS WERE ALIGNED PARALLEL TO THE S/C SPIN AXIS AND EXTENDED THROUGH THE BASE PLATE. IT CONSISTS OF A 1/2-IN VIDICON TUBE AND A FOCAL-PLANE SHUTTER THAT PERMITS STORAGE OF STILL PICTURES ON THE TUBE SCREEN.AN ELECTRON BEAM CONVERTS THE STORED PICTURES INTO TELEVISION-TYPE ELECTRONIC SIGNALS, WHICH CAN BE TRANSMITTED TO GROUND RECEIVERS ON COMMAND. THE SYSTEM CAN ALSO PROCESS AND STORE UP TO 32 PICTURES ON MAGNETIC TAPE FOR TRANS-MISSION AT A LATER TIME. THE CAMERA HAS A WIDE ANGLE(105 DEG) ELGEET F/1.5 LENS PRODUCING A RESOLUTION OF 1.4 TO 2.0 NM. THE CAMERA HAS A SHUTTER SPEED OF 1.5 MILLISEC AND A VIDEO-BANDWIDTH OF 62.5 KHZ. THE 500 LINE FRAME IS PROCESSED FOR STORAGE IN 2 SEC. A MINIMUM INTERVAL OF 10 SEC BETWEEN PICTURES IS REQUIRED FOR THE TARGET IMAGE TO BE ELECTRICALLY ERASED. THE CAMERA IS A-LIGNED PARALLEL TO THE SATELLITE'S SPIN AXIS AND IS AUTOMATICAL-LY TRIGGERED SO AS TO BE IN A PICTURE TAKING MODE ONLY WHEN DI-RECTED TOWARD THE EARTH. TRANSMISSION OF THE ENTIRE REEL OF 32 PICTURES CAN BE ACCOMPLISHED IN 100 SEC BY A 2-WATT FM TRANS-MITTER OPERATING AT A NOMINAL FREQUENCY OF 235 MHZ.

#### 32. PHENOMENA OBSERVED

CLOUD COVER AND THE EARTH'S SURFACE

#### 33. MEASUREMENT RANGE

7 TO 8 LEVELS OF GRAY

| 35. SPECTRAL RANGE 36. SPECTRAL RESOLUTION 37. TIME CONSTANT                             |          |
|--|----------|
| O.5 TO O.65 MICRONS NA   |          |
| 38. FIELD OF VIEW 39. GROUND SWATH   | j        |
| 74.0 BY 74.0 DEG 725 NM BY 725 NM FROM 400 NM ALTITUDE                                   |          |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION  |          |
| 0.2 DEG 1.4 NM PER TV LINE FROM 400 NM ALTITUDE  |          |
| 42. POINTING ACCURACY 43. POINTING RATE 44. ALTITUDE 45. INCLINATION                     |          |
| MED CIRCULAR MEDIUM POSIGRAD   | F        |
| 46. SPECIAL REQUIREMENTS   |          |
| 40. SECIAL REGUINEWERTS  |          |
|  |          |
| 47. COMPONENTS   |          |
| TV CAMERA, TRANSMITTER, TAPE RECORDER  |          |
| 48. WEIGHT 49. VOLUME 50. AVERAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF        |          |
| 7 LB 9 WATTS NONE 9 WATTS  |          |
| 54. INTERFERENCE 56. INTERFERENCE 59. INTERFERENCE 57. INTERFERENCE 58. SHIELDING        |          |
| SENSITIVE MAGNETIC SHIELDING USE   | D        |
| 59. CALIBRATION 60. DATA RECOVERY 61. FREQUENCY OF OBSERVATION                           | 1        |
| NO IN-FLIGHT CALIBRATION DELAYED AND REALTIME DAYSIDE OF ORBIT                           |          |
| 62. TELEMETRY REQUIREMENTS   |          |
| FULL REEL OF 32 PICTURES CAN BE READ OUT IN 100 SECONDS USING                            |          |
|  | Ì        |
| AN FM TRANSMITTER OPERATING AT FREQUENCY OF 235 MHZ.                                     | 1        |
|  |          |
| 63. ADVANTAGES AND LIMITATIONS   |          |
| BROAD SYNOPTIC VIEWING OF CLOUD-COVER PATTERNS. MORE VALUABLE                            |          |
| DATA FOR WEATHER ANALYSIS THAN FROM MED OR NARROW ANGLE CAMERA                           | <b>S</b> |
| 64. REFERENCES   |          |
| 1) SIGNIFICANT ACHIEVEMENTS IN SAT MET 1958-1964. NASA SP-96. **                         | *        |
| 2) GOLDBERG, E.A. AND LANDON, V.D.: KEY EQUIP FOR TIROS 1. ASTR                          |          |
| NAUTICS, V.5. JUNE 1960. *** 3) MESNER, M.H. AND STANISZEWSKI, J.                        |          |
| TV CAMERAS FOR SPACE EXPLOR. ASTRONAUTICS. V.5. MAY 1960.***                             | ·        |
| 4) INSTRUMENTS AND SPACECRAFT. NASA SP-3028, 1966. ***5) DATA                            |          |
| •  | ~        |
| AVAILABLE FROM NATIONAL WEATHER RECORDS CTR (ESSA), ASHEVILLE, N 165. HISTORICAL REMARKS | <u></u>  |
|  |          |
| IDENTICAL CAMERA FLOWN ON TIROS 1-10. SIMILAR CAMERA ON ESSA 1                           | •        |
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### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771

| 1. TITLE             |                   |                          |                    |         |                   |       | 2                  | ACRONYM              | 3. EXP NO |                 |  |
|----------------------|-------------------|--------------------------|--------------------|---------|-------------------|-------|--------------------|----------------------|-----------|-----------------|--|
| VIDICON              | CAMERA SYSTE      | M                        |                    |         | -                 |       | V                  | CSW                  |           |                 |  |
| (TITLE CONT.         | )                 |                          | -                  |         |                   |       | 4. R               | ESUME DATE           |           | 5.<br>VERSION   |  |
| WIDE-ANG             | LE LENS           |                          |                    |         |                   | C     | 9/01/              |                      |           |                 |  |
| 6. PRINCIPAL II      | NVESTIGATOR       | 7. OR                    | GANIZATION         |         |                   | 8. TI | ELEPHO             | NE                   |           |                 |  |
| RADOS, R             | .M. (MGR.)        | GODDARD SPACE FLT CENTER |                    |         |                   | 30    | 1-98               | 2-504                | 2         |                 |  |
|                      |                   |                          | GANIZATION         |         |                   | 11. T | ELEPHO             | NE                   |           |                 |  |
|                      |                   |                          |                    |         |                   |       |                    |                      |           |                 |  |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER                       | 14. FLASH INDEX NU | MBER    | 15. START<br>DATE | 16. C | OMPLETION<br>DATE  | 17. STAT             | US        |                 |  |
|                      |                   |                          |                    |         |                   |       |                    | POST                 | F١        | IGHT            |  |
| 18. MONITOR          |                   | 19. AG                   | ENCY               | 20. PGN | OFFICE            | 21. T | ELEPHO             | IONE                 |           |                 |  |
| TEPPER,              | М.                | NAS                      | A HDQTRS           | DA/     | ERD               | 20    | 2 <b>-7</b> 5      | 5 <del>-</del> 232.  | 2         |                 |  |
| 22. VENDOR           |                   |                          | 23. LOCATION       |         |                   | •     | 24. FLIGHT<br>DATE | FLIGHT 25. LEAD TIME |           |                 |  |
| RCA ASTR             | O ELECTRONIC      | S                        | PRINCETON,         | NEW     | JERSE!            | Υ     | 067                | 63 NA                |           |                 |  |
| 26. INSTRUMEN        | T TYPE            |                          |                    |         |                   |       |                    |                      |           | 27.<br>SECURITY |  |
| IMAGER,              | 0.5-INCH WID      | E-AN                     | GLE F/1.5 LO       | W-RE    | SOLUT             | ION   | VID                | ICON                 |           | UNC             |  |
| 28. APPLICATIO       | N                 |                          |                    |         | 29. SPACE         | CRAF  | T                  |                      |           |                 |  |
| MET                  |                   | •                        |                    |         | TIROS             | 7     |                    |                      |           |                 |  |
| 30. PURPOSE          |                   |                          |                    |         |                   |       |                    |                      |           |                 |  |

PRIMARY-TO ACQUIRE AND TRANSMIT PICTURES OF THE EARTH'S CLOUD COVER TO PROVIDE METEOROLOGISTS WITH DETAILED INFORMATION ON INDIVIDUAL CLOUD TYPES OVER SPECIFIC AREAS.\*\*\*SECONDARY-TO TEST TV SENSOR IN SPACE.

#### 31. PRINCIPLES OF OPERATION

THIS CAMERA SUB-SYSTEM HAS FLOWN IN AN IDENTICAL CONFIGURATION ON TIROS 1-10 AND SIMILAR CONFIGURATION ON ESSA 1, HOWEVER, ON THIS FLIGHT(TIROS 7) 2 WIDE ANGLE CAMERAS WERE USED. IT CONSISTS OF A 1/2 IN VIDICON TUBE AND A FOCAL-PLANE SHUTTER THAT PERMITS STURAGE OF STILL PICTURES ON THE TUBE SCREEN. AN ELECTRON BEAM CONVERTS THE STORED PICTURES INTO TELEVISION-TYPE ELECTRONIC SIGNALS, WHICH CAN BE TRANSMITTED TO GROUND RECEIVERS ON COMMAND. THE SYSTEM CAN ALSO PROCESS AND STORE UP TO 32 PICTURES ON MAG-NETIC TAPE FOR TRANSMISSION AT A LATER TIME. THE CAMERA HAS A WIDE ANGLE(105 DEG) ELGEET F/1.5 LENS PRODUCING A RESOLUTION OF 1.4 TO 2.0 NM. THE CAMERA HAS A SHUTTER SPEED OF 1.5 MILLSEC AND A VIDEO-BANDWIDTH OF 62.5 KHZ. THE 500 LINE FRAME IS PRO-CESSED FOR STORAGE IN 2 SECS. A MINIMUM INTERVAL OF 10 SEC BE-TWEEN PICTURES IS REQUIRED FOR THE TARGET IMAGE TO BE ELECTRI-CALLY ERASED. THE CAMERA IS ALIGNED PARALLEL TO THE SATELLITES SPIN AXIS AND IS AUTOMATICALLY TRIGGERED SO AS TO BE IN A PIC-TURE TAKING MODE ONLY WHEN DIRECTED TOWARD THE EARTH. TRANSMIS-SION OF THE ENTIRE REEL OF 32 PICTURES CAN BE ACCOMPLISHED IN 100 SEC BY A 2-WATT FM TRANSMITTER OPERATING AT A NOMINAL FRE-QUENCY OF 235 MHZ.

#### 32. PHENOMENA OBSERVED

CLOUD COVER AND THE EARTH'S SURFACE

#### 33. MEASUREMENT RANGE

7 TO 8 LEVELS OF GRAY

| 35. SPECTRAL RANGE                     | 36. SPECTRAL RESOLUTION 37. TIME CONSTANT                   |
|--|---|
|  |   |
|  |   |
| 38. FIELD OF VIEW                      | 39. GROUND SWATH  |
|  | 750 NM BY 750 NM FROM 475 NM ALTITUDE                       |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES | OLUTION   |
| 0.2 DEG 1.5 NM PE                      | R TV-LINE FROM 475 NM ALTITUDE                              |
| 42. POINTING ACCURACY 43. POINTING RAT |   |
| TO THE MAN THE TAX TO THE THE TAX      | MED CIRCULAR MEDIUM POSIGRADE                               |
| AC CRECIAL RECURRENCE                  | THEO CINCOLAN THEOLOGY POSIGNADE                            |
| 46. SPECIAL REQUIREMENTS               |   |
|  |   |
| 47. COMPONENTS                         |   |
| TV CAMERA, TRANSMITTER                 | • TAPE RECORDER   |
| 48. WEIGHT 49. VOLUME                  | 50. AVERAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF |
| 7 LB                                   | 9 WATTS NONE 9 WATTS  |
|  |   |
|  | NUCLEAR 57 THERMAL 58. SHIELDING                            |
| SENSITIVE                              | MAGNETIC SHIELDING USED                                     |
| 59. CALIBRATION                        | 60. DATA RECOVERY 61. FREQUENCY OF OBSERVATION              |
| NO IN-FLIGHT CALIBRATI                 | ON DELAYED AND REALTIME DAYSIDE OF ORBIT                    |
| 62. TELEMETRY REQUIREMENTS             | 1   |
|  | ES CAN BE READ OUT IN 100 SECONDS USING                     |
|  |   |
| AN FM TRANSMITTER UPER                 | ATING AT FREQUENCY OF 235 MHZ.                              |
|  | ,   |
| 63. ADVANTAGES AND LIMITATIONS         |   |
| BROAD SYNORTIC VIEWING                 | OF CLOUD-COVER PATTERNS. MORE VALUABLE                      |
|  | SIS THAN FROM MED OR NARROW ANGLE CAMERAS                   |
| 64. REFERENCES                         | STS THAN THUM MED ON MARKON ANGLE CAMERAS                   |
|  |   |
|  | ENTS IN SAT MET 1958-1964. NASA SP-96.***                   |
| 2)GOLDBERG, E.A. AND LA                | NDON, V.D.: KEY EQUIP FOR TIROS 1. ASTRO-                   |
| NAUTICS. V.5. JUNE 196                 | O.***3)MESNER,M.H. AND STANISZEWSKI, J.:                    |
|  | XPLOR. ASTRONAUTICS, V.5, MAY 1960.***                      |
|  |   |
|  | CECRAFT. NASA SP-3028, 1966. ***5) DATA                     |
|  | L WEATHER RECORDS CTR (ESSA), ASHEVILLE, NC.                |
| 65. HISTORICAL REMARKS                 |   |
| IDENTICAL CAMERA FLOWN                 | ON TIROS 1-10. SIMILAR CAMERA ON ESSA 1.                    |
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#### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771

| 1. TITLE                           |   |                              |              |         |                   |       | 2. /              | CRONYM                   | 3.   | 3. EXP NO       |  |  |  |
|------------------------------------|---|------------------------------|--------------|---------|-------------------|-------|-------------------|--------------------------|------|-----------------|--|--|--|
| VIDICON (                          | CAMERA SYSTEM                           | 4                            |              |         |                   |       | VC                | SW                       |      |                 |  |  |  |
| (TITLE CONT.                       | )                                       |                              |              |         |                   |       | 4. R              | 4 RESUME DATE S. VERSION |      |                 |  |  |  |
| WIDE-ANG                           | LE LENS                                 |                              |              |         |                   | 09    | 9/01/7            | 72                       | 0005 |                 |  |  |  |
| 6. PRINCIPAL INVESTIGATOR 7. OF    |   |                              | GANIZATION   |         |                   | 8. TI | ELEPHO            | NE                       |      |                 |  |  |  |
| RADOS, R.                          | OS, R.M. (MGR.) GODDARD SPACE FLT CENTE |                              |              | ENTER   | 301               | 1-982 | 2-5042            |                          |      |                 |  |  |  |
| 9. CO-INVESTIGATOR 10. C           |   |                              | GANIZATION   |         |                   | 11. T | ELEPHO            | NE                       |      |                 |  |  |  |
|                                    |   |                              |              |         |                   |       |                   |                          |      |                 |  |  |  |
| 12. CONTRACT<br>TYPE               | 13. CONTRACT NUMB                       | BER 14. FLASH INDEX NUMBER 1 |              |         | 15. START<br>DATE | 16. C | OMPLETION<br>DATE | 17. STAT                 | rus  |                 |  |  |  |
|                                    |   |                              |              |         |                   |       |                   | POST                     | FL   | IGHT            |  |  |  |
| 18. MONITOR                        |   | 19. AG                       | ENCY         | 20. PGM | OFFICE            | 21. T | ELEPHO            | ONE                      |      |                 |  |  |  |
| TEPPER, 1                          | ٧.                                      | NASA                         | A HDQTRS     | OA/     | EŔD               | 202   | 2-75              | -2322                    | 2    |                 |  |  |  |
| 22. VENDOR                         |   |                              | 23. LOCATION |         |                   |       | 24. FLIGH<br>DATE | <sup>1</sup> 25. L       | EAC  | TIME            |  |  |  |
| RCA ASTR                           | D-ELECTRONICS                           | 5                            | PRINCETON, N | V. J.   | •                 |       | 12/6              | 3 NA                     |      |                 |  |  |  |
| 26. INSTRUMEN                      | IT TYPE                                 |                              |              |         |                   |       |                   |                          |      | 27.<br>SECURITY |  |  |  |
| IMAGER, WIDE-ANGLE F/1.5 LOW-RESOL |   |                              |              | ION     | 0.5-11            | VCH   | VIDI              | CON                      |      | UNC             |  |  |  |
| 28. APPLICATION                    |   |                              |              | 2       | 9. SPACE          | CRAF  | T                 |                          |      |                 |  |  |  |
| MET                                |   |                              |              |         | TIROS             | 8 -   |                   |                          |      |                 |  |  |  |
|                                    |   |                              |              |         |                   |       |                   |                          |      |                 |  |  |  |

#### 30. PURPOSE

PRIMARY-TO ACQUIRE AND TRANSMIT PICTURES OF THE EARTH'S CLOUD COVER TO PROVIDE METEUROLOGISTS WITH DETAILED INFORMATION ON INDIVIDUAL CLOUD TYPES OVER SPECIFIC AREAS.\*\*\*SECONDARY-TO TEST TV SENSOR IN SPACE.

#### 31. PRINCIPLES OF OPERATION

THIS CAMERA SUB-SYSTEM HAS FLOWN IN AN IDENTICAL CONFIGURATION ON TIROS 1-10 AND SIMILAR CONFIGURATION ON ESSA 1. ON TIROS 1-8. 10 THE CAMERAS WERE ALIGNED PAPALLEL TO THE S/C SPIN AXIS AND EXTENDED THROUGH THE BASE PLATE. IT CONSISTS OF A 1/2-IN VIDICON TUBE AND A FOCAL-PLANE SHUTTER THAT PERMITS STORAGE OF STILL PICTURES ON THE TUBE SCREEN. AN ELECTRON BEAM CONVERTS THE STORED PICTURES INTO TELEVISION-TYPE ELECTRONIC SIGNALS, WHICH CAN BE TRANSMITTED TO GROUND RECFIVERS ON COMMAND. THE SYSTEM CAN ALSO PROCESS AND STORE UP TO 32 PICTURES ON MAGNETIC TAPE FOR TRANS-MISSION AT A LATER TIME. THE CAMERA HAS A WIDE-ANGLE (105 DEG) ELGEET F/1.5 LENS PRODUCING A RESOLUTION OF 1.4 TO 2.0 NM. THE CAMERA HAS A SHUTTER SPEED OF 1.5 MILLISEC AND A VIDEO-BANDWIDTH OF 62.5 KHZ. THE 500 LINE FRAME IS PROCESSED FOR STORAGE IN 2 SEC. A MINIMUM INTERVAL OF 10 SEC BETWEEN PICTURES IS REQUIRED FOR THE TARGET IMAGE TO BE ELECTRICALLY ERASED. THE CAMERA IS ALIGNED PARALLEL TO THE SATELLITES SPIN AXIS AND IS AUTOMATICAL-LY TRIGGERED SO AS TO BE IN A PICTURE TAKING MODE ONLY WHEN DI-RECTED TOWARD THE EARTH. TRANSMISSION OF THE ENTIRE REEL OF 32 PICTURES CAN BE ACCOMPLISHED IN 100 SEC BY A 2-WATT FM TRANS-MITTER OPERATING AT A NOMINAL FREQUENCY OF 235 MHZ.

#### 32. PHENOMENA OBSERVED

CLOUD COVER AND THE EARTH'S SUPFACE

#### 33. MEASUREMENT RANGE

7 TO 8 LEVELS OF GRAY



| 35. SPECTRAL RANGE                                    | 36. SPECTRAL RE              | SOLUTION 37. TIME CONSTANT   |
|---|------------------------------|--|
|   | [CRONS] NA                   |  |
|   | OUND SWATH                   | THE ALTERNATION  |
|   |                              | DM 450 NM ALTITUDE   |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION         |                              | A A TI TUDE  |
|   | -LINE FROM 450 N             |  |
| 42. POINTING ACCURACY 43. POINTING RATE               | 44. ALTITUDE                 | 45. INCLINATION  |
|   | MED CIRCULAR                 | MEDIUM POSIGRADE   |
| 46. SPECIAL REQUIREMENTS                              | <u> </u>                     | · · · · · · · · · · · · · · · · · · ·  |
|   |                              |  |
| 47. COMPONENTS  | 5 05500550                   |  |
| TV CAMERA, TRANSMITTER, TAI                           |                              | TEO DEAK DOWED LEG MEDE  |
|   | PERAGE POWER 51. STANDBY POW | VER 52. PEAK POWER 53. MTBF  |
| 7 LB  | 9 WATTS NONE                 |  |
| S4. INTERFERENCE S5. INTERFERENCE S6. INTERFERENCE    |                              | CHIELDING  CONTROL  C |
| SENSITIVE   |                              |  |
| 59. CALIBRATION   60.   NO IN-FLIGHT CALIBRATION D    | DATA RECOVERY                | 61. FREQUENCY OF OBSERVATION   |
|   | CLATEU AND KEALT             | IME DATSIVE UP UKDIT   |
| FULL REEL OF 32 PICTURES C                            | AN DE DEAD OUT TO            | N 100 SECONDS HSTNC  |
| AN FM TRANSMITTER OPERATING                           |                              |  |
| AN PM IRANSMITTER UPERATING                           | S AT PREQUENCT U             | r 233 MH.C.  |
| 63. ADVANTAGES AND LIMITATIONS                        |                              |  |
|   | CLOUD COVER DATE             | TOUC MODE WALLADIE   |
| BROAD SYNOPTIC VIEWING OF                             |                              | · _  |
| DATA FOR WEATHER ANALYSIS 164. REFERENCES             | HAN FRUM MED UK              | NARRUW ANGLE CAMERAS   |
|   | TH CAT HET LOSO              | 10// NACA CO-0/ ***  |
| 1) SIGNIFICANT ACHIEVEMENTS                           |                              |  |
| 2) GOLDBERG, E.A. AND LANDOI                          | · · ·                        |  |
| NAUTICS, V.5, JUNE 1960.**                            | -                            | ·  |
| TV CAMERAS FOR SPACE EXPLOS                           |                              |  |
| 4) INSTRUMENTS AND SPACECR AVAILABLE FROM NATIONAL WE |                              | -  |
| 65. HISTORICAL REMARKS                                | THER RECORDS CT              | TESSAT ASHLVILLE INC.  |
| IDENTICAL CAMERA FLOWN ON                             | TIONS 1-10 STATE             | AD CAMEDA ON ESSA 1  |
| IDENTICAL CAMERA PLOWN ON                             | 11KUS 1-10. SIMI             | LAR CAMERA UN ESSA I.  |
|   |                              | <b>'</b>   |
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| 1. TITLE                  |                   |                          | •                  |        |                   | 2.7   | 2. A               | CRON       | ΥM          | 3. EXP NO |                 |  |  |  |
|---------------------------|-------------------|--------------------------|--------------------|--------|-------------------|-------|--------------------|------------|-------------|-----------|-----------------|--|--|--|
| VIDICON                   | CAMERA SYSTE      | Μ                        |                    | _      |                   |       | VC                 | SW         |             |           |                 |  |  |  |
| (TITLE CONT.              | .)                |                          |                    |        |                   |       | 4. RI              | ESUME      | DATE        |           | 5.<br>VERSION   |  |  |  |
| WIDE-ANG                  | LE LENS           |                          |                    |        |                   |       | 09                 | 70         | 7           | 72        | 0005            |  |  |  |
| 6. PRINCIPAL II           | NVESTIGATOR       | 7. OR                    | GANIZATION         |        |                   | 8. T  | ELEPHO             | NE         |             |           |                 |  |  |  |
| RADOS, R                  | .M. (MGR.)        | GODDARD SPACE FLT CENTER |                    |        | 30                | 1-982 | 2-5                | 042        | 2           |           |                 |  |  |  |
| 9. CO-INVESTIGATOR 10. OR |                   |                          | GANIZATION         |        |                   | 11. T | ELEPHO             | NE         |             |           |                 |  |  |  |
|                           |                   |                          |                    |        |                   |       |                    |            |             |           |                 |  |  |  |
| 12. CONTRACT<br>TYPE      | 13. CONTRACT NUME | ER                       | 14. FLASH INDEX NU | MBER   | 15. START<br>DATE | 16. C | OMPLETION<br>DATE  | 17. STATUS |             |           |                 |  |  |  |
|                           |                   |                          |                    |        |                   |       |                    | PO:        | ST          | FL        | IGHT            |  |  |  |
| 18. MONITOR               |                   | 19. AG                   | ENCY               | 20. PG | M OFFICE          | 21. T | ELEPHO             | ONE        | E           |           |                 |  |  |  |
| GARBACZ,                  | M.L.              | NAS                      | A HDQTRS           | OA A   | 'ERO              | 202   | 2-755              | 5-2        | <u> 322</u> | 2         |                 |  |  |  |
| 22. VENDOR                |                   |                          | 23. LOCATION       |        |                   |       | 24. FLIGHT<br>DATE | 2          | 5. L        | EAD       | TIME            |  |  |  |
| RCA ASTR                  | O-ELECTRONIC      | S                        | PRINCETON, 1       | ٧. ر   | ١.                |       | 01/6               | 5 1        | NΑ          |           |                 |  |  |  |
| 26. INSTRUMEN             | IT TYPE           |                          |                    |        |                   |       |                    |            |             |           | 27.<br>SECURITY |  |  |  |
| IMAGER, WIDE-ANGLE F/1.5  |                   |                          | LOW-RESOLUT        | ION    | 0.5-11            | VCH   | VIDI               | COI        |             |           |                 |  |  |  |
| 28. APPLICATION           |                   |                          |                    |        | 29. SPACE         | CRAF  | T                  |            |             |           |                 |  |  |  |
| MET                       |                   |                          |                    |        | TIROS             | 9     |                    |            |             |           |                 |  |  |  |
| 30. PURPOSE               |                   |                          |                    |        |                   |       |                    |            |             |           |                 |  |  |  |

PRIMARY-TO ACQUIRE AND TRANSMIT PICTURES OF THE EARTH'S CLOUD COVER TO PROVIDE METEOROLOGISTS WITH DETAILED INFORMATION ON INDIVIDUAL CLOUD TYPES OVER SPECIFIC AREAS.\*\*\*SECONDARY-TO TEST

TV SENSOR IN SPACE.

#### 31. PRINCIPLES OF OPERATION

THE TIROS 9 WIDE ANGLE TV CAMERA WAS IDENTICAL TO THOSE CARRIED ON ALL TIROS MISSIONS AND ESSA 1. HOWEVER, THIS FLIGHT CAPRIED 2. IN A NEW CONFIGURATION(CARTWHEEL), MOUNTED ON THE SIDE OF THE SPACECRAFT AND CANTED 26 DEG TO EACH SIDE OF THE PLANE OF THE SATELLITE'S ROTATION(10RPM). EACH CAMERA WAS AUTOMATICALLY TRIG-GERED SO AS TO BE IN A PICTURE TAKING MODE ONLY WHEN VIEWING THE EARTH(ONCE EACH ORBIT). EACH CAMERA CONSISTS OF A 1/2-INCH VIDI-CON TUBE AND A FOCAL-PLANE SHUTTER THAT PERMITS STORAGE OF STILL PICTURES ON THE TUBE SCREEN. AN ELECTRON BEAM CONVERTS THE STORED PICTURES INTO TV-TYPE ELECTRONIC SIGNALS, WHICH CAN BE TRANSMITTED TO GROUND RECEIVERS ON COMMAND. THE SYSTEM CAN ALSO PROCESS AND STORE UP TO 48 PICTURES ON MAGNETIC TAPE FOR LATER TRANSMISSION. THE CAMERA HAS A WIDE-ANGLE (105 DEG) ELGEET F/1.5 LENS. THE CAMERA HAS A SHUTTER SPEED OF 1.5 MILLISEC AND A VIDEO BANDWIDTH OF 62.5 KHZ. THE 500 LINE FRAME IS PROCESSED FOR STORAGE IN 2 SECS. A MINIMUM INTERVAL OF 10 SEC BETWEEN PICTURES IS REQUIRED FOR THE TARGET IMAGE TO BE ELECTRICALLY ERASED. TRANSMISSION OF THE ENTIRE REEL OF 48 PICTURES CAN BE ACCOM-PLISHED IN 120 SECONDS USING A 5-WATT FM TRANSMITTER OPERATING AT A NOMINAL FREQUENCY OF 235 MHZ.

#### 32. PHENOMENA OBSERVED

CLOUD COVER AND THE EARTH'S SURFACE

#### 33. MEASUREMENT RANGE

7 TO 8 LEVELS OF GRAY

| 35. SPECTRAL RANGE                     | 36. SPECTRAL RESOLUTION                 | ON 37. TIME CONSTANT                  |  |  |  |  |  |  |  |
|--|---|---------------------------------------|--|--|--|--|--|--|--|
| 0.5 TO 0.65                            | MICPONS NA                              |                                       |  |  |  |  |  |  |  |
| 38. FIELD OF VIEW                      | 39. GROUND SWATH                        |                                       |  |  |  |  |  |  |  |
| 74.0 BY 74.0 DEG                       | 750 NM BY 750 NM FROM 50                | O NM ALTITUDE                         |  |  |  |  |  |  |  |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES | DLUTION                                 |                                       |  |  |  |  |  |  |  |
| 0.2 DEG 1.5 NM PER                     | TV LINE FROM 500 NM ALT                 | ITUDE                                 |  |  |  |  |  |  |  |
| 42. POINTING ACCURACY 43. POINTING RAT | 44. ALTITUDE 45. INC                    | LINATION                              |  |  |  |  |  |  |  |
|  | MED ECCENTRIC MEDI                      | UM POSIGRADE                          |  |  |  |  |  |  |  |
| 46. SPECIAL REQUIREMENTS               |   |                                       |  |  |  |  |  |  |  |
|  |   |                                       |  |  |  |  |  |  |  |
| 47. COMPONENTS                         |   |                                       |  |  |  |  |  |  |  |
| TV CAMERA, TRANSMITTER                 | TAPE RECORDER                           |                                       |  |  |  |  |  |  |  |
| 48. WEIGHT 49. VOLUME                  | 50. AVERAGE POWER 51. STANDBY POWER 52. | PEAK POWER 53. MTBF                   |  |  |  |  |  |  |  |
| 7 LB                                   | 9 WATTS NONE                            | 9 WATTS                               |  |  |  |  |  |  |  |
| 54. INTERFERENCE 55. MAGNETIC 56. INTE | UCLEAR ST. INTERFERENCE 58. SHIELDIN    | IG .                                  |  |  |  |  |  |  |  |
| SENSITIVE                              | MAGNETI                                 | C SHIELDING USED                      |  |  |  |  |  |  |  |
| 59. CALIBRATION                        | 60. DATA RECOVERY 61                    | FREQUENCY OF OBSERVATION              |  |  |  |  |  |  |  |
| NO IN-FLIGHT CALIBRATIO                | IN DELAYED AND REALTIME D               | AYSIDE OF ORBIT                       |  |  |  |  |  |  |  |
| 62. TELEMETRY REQUIREMENTS             |   |                                       |  |  |  |  |  |  |  |
| FULL REEL OF 48 PICTURE                | S CAN BE READ OUT IN 120                | SECONDS USING                         |  |  |  |  |  |  |  |
|  | TING AT FREQUENCY OF 235                |                                       |  |  |  |  |  |  |  |
|  |   | ·                                     |  |  |  |  |  |  |  |
| 63. ADVANTAGES AND LIMITATIONS         |   |                                       |  |  |  |  |  |  |  |
| BROAD SYNOPTIC VIEWING                 | OF CLOUD COVER PATTERNS.                | MORE VALUABLE                         |  |  |  |  |  |  |  |
|  | IS THAN FROM MED OR NARRI               |                                       |  |  |  |  |  |  |  |
| 64. REFERENCES                         |   |                                       |  |  |  |  |  |  |  |
| 1) SIGNIFICANT ACHIEVEME               | NTS IN SAT MET 1958-1964                | NASA SP-96.***                        |  |  |  |  |  |  |  |
|  | NDON, V.D.: KEY EQUIP FO                |                                       |  |  |  |  |  |  |  |
|  | .***3)MESNER, M.H. AND S                |                                       |  |  |  |  |  |  |  |
|  | PLOR. ASTRONAUTICS, V.5,                | · · · · · · · · · · · · · · · · · · · |  |  |  |  |  |  |  |
|  | ECRAFT. NASA SP-3028, 19                |                                       |  |  |  |  |  |  |  |
|  | WEATHER RECORDS CTR (ES                 |                                       |  |  |  |  |  |  |  |
| 65. HISTORICAL REMARKS                 |   |                                       |  |  |  |  |  |  |  |
| BASIC CAMERA IDENTICAL                 | TO THOSE FLOWN ON TIRDS                 | 1-10 AND ESSA 1.                      |  |  |  |  |  |  |  |
|  |   |                                       |  |  |  |  |  |  |  |
|  |   |                                       |  |  |  |  |  |  |  |
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| 1. TITLE                        |                   |        |                                       |           |          |                  | 2. /                      | ACRONYM                   | 3. EXP NO |                 |  |  |
|---------------------------------|-------------------|--------|---------------------------------------|-----------|----------|------------------|---------------------------|---------------------------|-----------|-----------------|--|--|
| VIDICON (                       | CAMERA SYSTEM     | 1      |                                       |           |          |                  | V                         | SW                        |           |                 |  |  |
| (TITLE CONT.                    | )                 |        |                                       |           |          |                  | 4. R                      | 4. RESUME DATE 5. VERSION |           |                 |  |  |
| WIDE-ANGI                       | LE LENS           |        |                                       |           |          | Ç                | 09/01/72 0005             |                           |           |                 |  |  |
| 6. PRINCIPAL INVESTIGATOR 7. OR |                   |        | GANIZATION                            |           |          | 8. T             | ELEPHO                    | NE                        |           |                 |  |  |
| RADOS, R.                       | .M. (MGR.)        | GOD    | DARD SPACE FL                         | ENTER     | 30       | 1-982            | 2-504                     | 2                         |           |                 |  |  |
| 9. CO-INVESTIGATOR 10. OR       |                   |        | GANIZATION                            |           |          | 11. T            | TELEPHO                   | NE                        |           |                 |  |  |
|                                 |                   |        |                                       |           |          |                  |                           |                           |           |                 |  |  |
| 12. CONTRACT<br>TYPE            | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NUMBER 15. START DATE |           |          | 16. <sup>C</sup> | 16. COMPLETION 17. STATUS |                           |           |                 |  |  |
|                                 |                   |        |                                       |           |          |                  |                           | POST                      | FL        | LIGHT           |  |  |
| 18. MONITOR                     |                   | 19. AG | ENCY                                  | 20. PG    | M OFFICE | 21.              | TELEPH                    | ONE                       |           |                 |  |  |
| GARBACZ,                        | M.L.              | NAS    | A HDQTRS                              | 04/       | 'ERO     | 20               | 2-755                     | 755-2322                  |           |                 |  |  |
| 22. VENDOR                      |                   |        | 23. LOCATION                          |           |          |                  | 24. FLIGH<br>DATE         | <sup>†</sup> 25. l        | _EAC      | TIME            |  |  |
| RCA ASTR                        | D ELECTRONICS     | 5      | PRINCETON, N                          | ٧         | ١.       |                  | 07/6                      | 55 NA                     |           |                 |  |  |
| <b>26. IN</b> STRUMEN           | T TYPE            |        |                                       |           |          |                  |                           |                           |           | 27.<br>SECURITY |  |  |
| IMAGER, N                       | WIDE-ANGLE FA     | /1.5   | LOW-RESOLUT                           | ION       | 0.5-11   | <b>VCH</b>       | VID                       |                           |           |                 |  |  |
| 28. APPLICATION                 |                   |        |                                       | 29. SPACE | CRAF     | -T               |                           |                           |           |                 |  |  |
| MET                             |                   |        |                                       | TIROS     | 10       |                  |                           |                           |           |                 |  |  |
| 30. PURPOSE                     |                   |        |                                       |           |          |                  |                           |                           |           |                 |  |  |

PRIMARY-TO ACQUIRE AND TRANSMIT PICTURES OF THE EARTH'S CLOUD COVER TO PROVIDE METEOROLOGISTS WITH DETAILED INFORMATION ON INDIVIDUAL CLOUD TYPES OVER SPECIFIC AREAS.\*\*\*SECONDARY-TO TEST TV SENSOR IN SPACE.

#### 31. PRINCIPLES OF OPERATION

THIS CAMERA SUB-SYSTEM HAS FLOWN IN AN IDENTICAL CONFIGURATION ON TIROS 1-10 AND SIMILAR CONFIGURATION ON ESSA 1. HOWEVER. ON THIS FLIGHT, TWO WIDE-ANGLE CAMERAS WERE USED. EACH CONSISTS OF A O.5-IN VIDICON TUBE AND A FOCAL-PLANE SHUTTER THAT PERMITS STORAGE OF STILL PICTURES ON THE TUBE SCREEN. AN ELECTRON BEAM CONVERTS THE STORED PICTURES INTO TELEVISION-TYPE ELECTRONIC SIGNALS, WHICH CAN BE TRANSMITTED TO GROUND RECEIVERS ON DEMAND. THE SYSTEM CAN ALSO PROCESS AND STORE UP TO 32 PICTURES ON MAG-NETIC TAPE FOR TRANSMISSION AT A LATER TIME. THE CAMERA HAS A WIDE-ANGLE (105 DEG) ELGEET F/1.5 LENS PRODUCING A RESOLUTION OF 1.4 TO 2.0 NM. THE CAMERA HAS A SHUTTER SPEED OF 1.5 MILLISEC AND A VIDEO-BANDWIDTH OF 62.5 KHZ. THE 500 LINE FRAME IS PRO-CESSED FOR STORAGE IN 2 SECS. A MINIMUM INTERVAL OF 10 SEC BE-TWEEN PICTURES IS REQUIRED FOR THE TARGET IMAGE TO BE ELECTRI-CALLY ERASED. THE CAMERA IS ALIGNED PARALLEL TO THE SATELLITES SPIN AXIS AND IS AUTOMATICALLY TRIGGERED SO AS TO BE IN A PIC-TURE TAKING MODE ONLY WHEN DIRECTED TOWARD THE EARTH. TRANSMIS-SION OF THE ENTIRE REEL OF 32 PICTURES CAN BE ACCOMPLISHED IN 100 SEC BY A 2-WATT FM TRANSMITTER OPERATING AT A NOMINAL FRE-QUENCY OF 235 MHZ.

#### 32. PHENOMENA OBSERVED

CLOUD COVER AND THE EARTH'S SURFACE

#### 33. MEASUREMENT RANGE

7 TO 8 LEVELS OF GRAY

|   | ·   |  |   |
|---|---|--|---|
| 35. SPECTRAL RANGE                      |   | ECTRAL RESOLUTION  | 37. TIME CONSTANT                       |
| 0.5 TO 0.65                             | MICRONS NA                                  |  |   |
| 38. FIELD OF VIEW                       | 39. GROUND SWATH                            |  |   |
| 74.0 BY 74.0 DEG                        | 725 NM BY 72                                | 5 NM FROM 450  | NM ALTITUDE                             |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESO | LUTION                                      | ,  | , |
| 0.2 DEG 1.4 NM PE                       | TV-I THE FRO                                | M 450 NM ALTIT   | UDF                                     |
| 42. POINTING ACCURACY 43. POINTING RATE | 44. ALTITUDE                                |  |   |
| 43.1 ONTING ACCORACT                    |   | RCULAR MEDIUN  |   |
|   | MED CI                                      | KCOLAR   MEDIO!  | POSTORADE                               |
| 46. SPECIAL REQUIREMENTS                | · · · · · · · · · · · · · · · · · · ·       |  |   |
|   |   | The second secon |   |
| 47. COMPONENTS                          |   |  |   |
| TV CAMERA, TRANSMITTER                  |   |  |   |
| 48. WEIGHT 49. VOLUME                   | 50. AVERAGE POWER 5                         | STANDBY POWER 52. PEA  | K POWER 53. MTBF                        |
| 7 LB                                    | 9 WATTS                                     | NONE   | WATTS                                   |
| 54. INTERFERENCE 55. MAGNETIC 56. INTER | CLEAR 57. THERMAL<br>FERENCE 57. INTERFEREN | 58. SHIELDING  |   |
| SENSITIVE                               |   |  | SHIELDING USED                          |
| 59. CALIBRATION                         | 60. DATA RECOVER                            |  | QUENCY OF OBSERVATION                   |
| NO IN-FLIGHT CALIBRATION                |   |  |   |
|   | IN DELATED AN                               | D REALITME DAT   | SIDE OF UNBIL                           |
| 62. TELEMETRY REQUIREMENTS              |   | 5 04 F 24 1 5 5 5  | ECONOC METING                           |
| FULL REEL OF 32 PICTUR                  |   |  |   |
| AN EM TRANSMITTER OPER                  | ITING AT FREQ                               | UENCY DF 235 M   | HZ•                                     |
|   |   |  |   |
| 63. ADVANTAGES AND LIMITATIONS          |   | •  |   |
| BROAD SYNOPTIC VIEWING                  | OF CLOUD COV                                | ER PATTERNS. M   | ORE VALUABLE                            |
| DATA FOR WEATHER ANALY                  |   |  |   |
| 64. REFERENCES                          | / 10 111 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1    |  | 7                                       |
| 1) SIGNIFICANT ACHIEVEM                 | NITC IN CAT M                               | ET 1050-1066   | MACA CD-Q2 AZAM                         |
|   |   |  |   |
| 2) GOLDBERG, E.A. AND LA                | •   |  |   |
| NAUTICS, V.5, JUNE 1969                 |   |  |   |
| TV CAMERAS FOR SPACE EX                 | (PLOR. ASTRON                               | AUTICS, V.5, N   | AY 1960.***                             |
| 4) INSTRUMENTS AND SPACE                | CECRAFT. NASA                               | SP-3028, 1966  | . ***5) DATA                            |
| AVAILABLE FROM NATIONAL                 | WEATHER REC                                 | ORDS CTR LESSA   | ),ASHEVILLE,NC.                         |
| 65. HISTORICAL REMARKS                  |   |  |   |
| IDENTICAL CAMERA FLOWN                  | ON TIROS 1-1                                | O. SIMILAR CAM   | FRA ON ESSA 1.                          |
|   |   | <u> </u>   |   |
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LASERS AND RADARS

|   |                   |        | DARD SPACE FLIGI<br>GREENBELT, MD.  |       | TER       |              |                         |          |      |                 |  |
|---|-------------------|--------|-------------------------------------|-------|-----------|--------------|-------------------------|----------|------|-----------------|--|
| 1. TITLE                                |                   |        |                                     |       |           |              | 2. AC                   | RONYM    | 3. E | XP NO           |  |
| LASER DET                               | ECTOR             |        |                                     |       |           |              | LDE                     | С        |      |                 |  |
| (TITLE CONT.                            | )                 |        |                                     |       |           |              | 4. RESU                 | ME DATE  | 5    | ERSION          |  |
|   |                   |        |                                     |       |           |              | 097                     | 01/7     | 2    | 004             |  |
| 6. PRINCIPAL IN                         | NVESTIGATOR       | 7. OR  | GANIZATION                          |       |           | 8. TELEPHONE |                         |          |      |                 |  |
| PLOTKIN, DR. H.H. GODDARD SPACE FLT CEN |                   |        |                                     | ENTER | 301       | -982-        | 5042                    |          |      |                 |  |
| 9. CO-INVESTIG                          | ATOR              | 10. OR | GANIZATION                          |       |           | 11. T        | ELEPHON                 | E        |      |                 |  |
|   |                   |        |                                     |       |           |              |                         |          |      |                 |  |
| 12. CONTRACT<br>TYPE                    | 13. CONTRACT NUME | BER    | ER 14. FLASH INDEX NUMBER 15. START |       |           |              | MPLETION 1              | 7. STAT  | US   |                 |  |
|   |                   |        |                                     |       |           | $\perp$      | 0                       | PERA     | TI   | DNAL            |  |
| 18. MONITOR 19. AGENCY 20. PGN          |                   |        |                                     |       |           | 21. T        | ELEPHON                 | E        |      |                 |  |
| ROSENBERG                               | 3, J.D.           | NASA   | A HDQTRS                            | OA/   | ECD       | 202          | 755-                    | 755-2322 |      |                 |  |
| 22. VENDOR                              |                   |        | 23. LOCATION                        |       |           |              | 24 FLIGHT 25. LEAD TIME |          |      |                 |  |
| WASHINGTO                               | N TECH. ASSO      | OC.    | C. ROCKVILLE, MARYLAND 01/68 NA     |       |           |              |                         |          |      |                 |  |
| 26. INSTRUMEN                           | Т ТҮРЕ            |        |                                     |       |           |              |                         |          |      | 27.<br>SECURITY |  |
| PHOTOMETE                               | R, 4880-ANG       | STROM  | 1 CW-LASER P                        | HOTO  | MULTIP    | LIE          | R DET                   | ECTO     | R    | UNC             |  |
| 28. APPLICATIO                          | N                 |        |                                     | 2     | 9. SPACEO | RAF          | T                       |          |      |                 |  |
| GEOD                                    |                   |        |                                     |       | GEOS 2    |              |                         |          |      |                 |  |
| 30. PURPOSE                             |                   |        |                                     |       |           |              |                         |          |      |                 |  |
| PRIMARY-T                               | O DETERMINE       | WHET   | THER LASER B                        | EAMS  | TRANS     | MIT          | TED T                   | 0 OR     | BII  | ING             |  |
| SATELLITE                               | S ARRIVE AT       | THE    | SATELLITE A                         | T PRE | EDICTE    | D P          | OWER                    | LEVE     | LS.  | ***             |  |
| SECONDARY                               | '-TO DETERMIN     | VE TH  | HE FREQUENCY                        | AND   | DEPTH     | OF           | MODU                    | LATI     | ON   | AND             |  |
| SCINTILLA                               | TION OF THE       | LASE   | ER BEAM AS V                        | TEWE  | ) FROM    | TH           | E SAT                   | ELLI     | TE.  | •               |  |
|   |                   |        |                                     |       |           |              |                         |          |      |                 |  |
|   |                   |        |                                     |       |           |              |                         |          |      |                 |  |

#### 31. PRINCIPLES OF OPERATION

THIS LASER DETECTOR WAS DESIGNED TO DETECT MODULATION OF AN ARGON LASER BEAM (4880 A WAVELENGTH) CHOPPED AT 13 KHZ. FIELD OF VIEW OF THE SYSTEM IS 80 DEG. A 0.6 IN (1.5 CM) DIA-METER APERTURE STOP AND A SET OF 2 LENSES THAT FORM A 2.2 IN (5.6 CM) FOCAL LENGTH, F/0.78 OBJECTIVE COLLIMATE THE LIGHT SO THAT THE BEAM STRIKES A WAVELENGTH FILTER WITHIN 8 DEG OF THE FILTER IS 2.70 IN (6.9 CM) IN DIAMETER WITH A PEAK TRANSMISSION OF 50 PERCENT AT 4890 A AND A HALF-POWER BANDWIDTH OF 46 A. TRANSMISSION OUTSIDE THIS PASSBAND IS LESS THAN 0.0063 PER CENT FROM 2500 TO 20000 A. AFTER THE FILTER, ANOTHER SET OF LENSES JUST LIKE THE OBJECTIVE CONDENSES THE LIGHT ONTO A 14 STAGE PHOTOMULTIPILER TUBE WITH A 1 IN (2.54 CM) DIAMETER BI-ALKALI PHOTOCATHODE (EMR TYPE 541D-C1-14). FROM HERE AN OUTPUT SIGNAL GOES INTO AN FET PREAMPLIRIER THEN INTO A PIEZO-ELECTRIC FILTER WITH A 160 HZ BANDPASS CENTERED AT 13 KHZ. THUS THIS DETECTOR IS SENSITIVE ONLY TO MODULATION IN FREQUENCY OF LESS (THE MODULATIONS ARE EXPECTED TO BE PREDOMINATELY THAN 80 HZ. LESS THAN 10 HZ.) AFTER DETECTION A LOG AMPLIFIER COMPRESSES THE SIGNAL RANGE OF 1000 INTO A -5 TO +5 V RANGE FOR TELEMETRY.

#### 32. PHENOMENA OBSERVED

CONTINUOUS-WAVE MODULATED ARGON-LASER LIGHT (4880 A).

#### 33. MEASUREMENT RANGE

O.1 TO 100 PICOWATT.

| 35. SPECTRAL RANGE                            |  | 36. SPECTRAL RESOL   | UTION 37. TIME CONSTANT               |
|---|--|--|---------------------------------------|
| 4880.   | Α  | NA   |                                       |
| 38. FIELD OF VIEW                             | 39. GROUND SW  |  |                                       |
|   |  | AM CIRCLE FRO  | M 600 NM ALTITUDE                     |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES        | OLUTION  | 1  |                                       |
| NA NA   |  |  |                                       |
| 42. POINTING ACCURACY 43. POINTING RAT        |  |  | INCLINATION                           |
| NA NA   | MED  | ECCENTRIC H  | GH RETROGRADE                         |
| 46. SPECIAL REQUIREMENTS                      |  |  |                                       |
| 47. COMPONENTS                                | the Committee of the Co | The second secon |                                       |
| PHOTOMULTIPLIER ASSEMB                        | ΙΥ   |  |                                       |
| 48. WEIGHT 49. VOLUME                         | 50. AVERAGE POV  | ER 51. STANDBY POWER   | 52. PEAK POWER 53. MTBF               |
| 4 LB 0.1 CU F                                 | T 2 WATT   | S  | 2 WATTS                               |
| 54. INTERFERENCE 55. MAGNETIC 56. INT         | NUCLEAR<br>ERFERENCE 57. IN  | THERMAL 58. SHIE   | LDING                                 |
|   |  |  |                                       |
| 59. CALIBRATION                               | 60. DATA RE  | COVERY   | 61: FREQUENCY OF OBSERVATION          |
|   | DELAYED  | TELEMETRY.   | 10 MIN PER DAY                        |
| 62. TELEMETRY REQUIREMENTS                    |  |  |                                       |
| DATA TELEMETERED VIA A                        | 136.32-MH  | Z -TRANSMITTER   | . BANDWIDTH NEEDED=                   |
| 80 HZ.  |  |  |                                       |
| 63. ADVANTAGES AND LIMITATIONS                | <del></del>  |  |                                       |
| <u></u>                                       |  |  |                                       |
|   |  |  |                                       |
| 64. REFERENCES                                |  |  |                                       |
| 11NASA PRESS KIT FOR G                        | EOS-B. REL   | EASE NO: 68-2  | K, JAN 7, 68. ***2)                   |
| PARAMETRIC ANALYSIS FO                        | R FUTURE G   | EDDETIC SPACE  | CRAFT DEVELOPMENT.                    |
| REPORT NO. R-4035-50-2                        |  |  | · · · · · · · · · · · · · · · · · · · |
| ***3) PLAN OF OPERATION                       |  | _  |                                       |
| 4035-2, COMMUNICATIONS                        |  |  |                                       |
| PERFORMANCE OF GEOS-LA 65. HISTORICAL REMARKS | SEK DETECT   | UK, 1MX-63222  | • UCI • 67 •                          |
| GEOS 2 IS ALSO KNOWN A                        | C EVOLOBED   | 3.6  |                                       |
| GEOS 2 13 ALSO KNOWN A                        | 3 EXPLUNER   | 30.  |                                       |
|   |  |  |                                       |
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| 1. TITLE                         |                   |            |                         |        |                   |        | 2.                | ACRON    | NYM 3. EXP NO |   |                 |   |  |  |
|----------------------------------|-------------------|------------|-------------------------|--------|-------------------|--------|-------------------|----------|---------------|---|-----------------|---|--|--|
| LASER RE                         | FLECTOR           |            |                         |        |                   |        |                   | REF      |               |   |                 |   |  |  |
| (TITLE CONT.                     | )                 |            |                         |        |                   |        | 4. F              | RESUME ( | ATE           |   | 5.<br>VERSION   |   |  |  |
|                                  |                   |            |                         |        |                   |        | 0                 | 9/0      | 7             | /2                                      | 3004            |   |  |  |
| 6. PRINCIPAL INVESTIGATOR 7. ORG |                   |            | GANIZATION 8. TELEPHONE |        |                   |        |                   |          |               |   |                 |   |  |  |
| PLOTKIN,                         | DR. H.H.          | GOD        | DARD SPACE FI           | LT (   | CENTER            | 30     | 1-98              | 2-5      | 342           | <u> </u>                                |                 |   |  |  |
| 9. CO-INVESTIG                   | ATOR              | GANIZATION |                         |        | 11. T             | ELEPHO | ONE               |          |               |   |                 |   |  |  |
|                                  |                   |            |                         |        |                   |        |                   |          |               |   |                 |   |  |  |
| 12. CONTRACT<br>TYPE             | 13. CONTRACT NUMB | ER         | 14. FLASH INDEX NU      | MBER   | 15. START<br>DATE | 16. C  | OMPLETION<br>DATE | 17. S    | 7. STATUS     |   |                 |   |  |  |
|                                  |                   |            |                         |        |                   |        |                   | OP!      | ER/           | TI                                      | ONAL            |   |  |  |
| 18. MONITOR                      |                   | 19. AG     | ENCY                    | 20. PG | M OFFICE          | 21. 1  | ELEPH             | ONE      |               |   |                 |   |  |  |
| ROSENBER                         | G, J.D.           | NAS        | A HDQTRS                | OA     | /ECD              | 20     | 202-755-2322      |          |               |   |                 |   |  |  |
| 22. VENDOR                       |                   |            | 23. LOCATION            |        |                   |        | 24. FLIGH<br>DATE | 17 2     | 5. L1         | EAD                                     | TIME            | _ |  |  |
| GE SPACE                         | T ECHNOLOGY       | CTR        | VALLEY FORGE            | Ε, [   | ΡΑ                |        | 01/               | 68 1     | VΑ            |   |                 |   |  |  |
| 26. INSTRUMEN                    | IT TYPE           |            |                         |        |                   |        |                   |          |               | ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, | 27.<br>SECURITY | • |  |  |
| REFLECTO                         | R, 400 1-INC      | H CU       | BICAL SILVER            | ED-1   | PRISM             |        |                   |          |               |   | UNC             |   |  |  |
| 28. APPLICATION                  |                   |            |                         |        | 29. SPACE         | CRAF   | T                 |          |               |   |                 |   |  |  |
| GEOD                             |                   |            |                         | GEOS   | 2                 |        |                   |          |               |   |                 |   |  |  |
| 30. PURPOSE                      |                   |            |                         |        |                   |        |                   |          |               |   |                 | • |  |  |
|                                  |                   |            |                         |        |                   |        |                   |          |               |   |                 |   |  |  |

PRIMARY-TO MAKE ACCURATE RANGE AND ANGLE MEASUREMENTS TO THE SATELLITE FROM ONE OR SEVERAL LOCATIONS SIMULTANEOUSLY, IN CONJUNCTION WITH LASER GROUND EQUIPMENT.\*\*\*SECONDARY-TO OBTAIN MEASUREMENTS OF CONTINENTAL DRIFT AND THE TIDAL MOVEMENT OF LAND MASSES.

#### 31. PRINCIPLES OF OPERATION

THIS IS AN ARRAY OF QUARTZ CUBIC CORNER REFLECTORS MOUNTED ON 4 OF THE 8 FLAT PANELS ON THE BOTTOM SURFACE OF THE SPACECRAFT. EACH REFLECTOR IS A FUSED QUARTZ PRISM ABOUT ONE INCH IN SIZE WITH SILVERED REFLECTING SURFACES. THERE ARE A TOTAL OF 400 PRISMS ON THE SPACECRAFT, PROVIDING A TOTAL REFLECTING AREA OF THE PRISMS ARE JOINED TO AN ACCURACY OF 3 360 SQUARE INCHES. ARC-SEC AND REFLECT AT LEAST 50% OF THE INCIDENT BEAM ANTI-PARALLEL WITHIN A 20 ARC-SEC CONE. THE EFFECTIVE USABLE ANGLE OF THE REFLECTORS IS CONTAINED WITHIN A CONE OF 40-DEG HALF-ANGLE FROM THE SATELLITE NADIR. WHEN THE SATELLITE IS WITHIN RANGE, THESE QUARTZ CUBES REFLECT BACK TO THE SOURCE THE HIGH-ENERGY SHORT-DURATION PULSES FIRED BY THE GROUND LOCATED LASER TRACKING SYSTEMS. THE REFLECTED LIGHT IS PICKED UP BY A TELE-SCOPE AND THEN A DIGITAL COUNTER MEASURES THE ROUND-TRIP TRAVEL TIME OF THE LIGHT PULSES. THIS GIVES THE DISTANCE TO THE SATEL-LITE AND THUS FORMS THE BASIS OF THE SATELLITE OPTICAL LASER TRACKING SYSTEM. PHOTOGRAPHING THE REFLECTION AGAINST THE STAR-FIELD YIELDS ANGULAR POSITION.

#### 32. PHENOMENA OBSERVED

HIGH-ENERGY SHORT-DURATION LASER PULSES FROM GROUND, STATIONS
33. MEASUREMENT RANGE

34. PRECISION AND ACCURACY

RANGE MEASUREMENT TO 1.5 METERS; PANGE-PATE TO ABOUT 1 CM/SEC

| 35. SPECTRAL      | RANGE                    |          | <del></del> | <del>-</del> | 36          | . SPECTRA    | AL RESO  | UTION       | 37. TIME                       | CONSTANT   | • .       |
|-------------------|--------------------------|----------|-------------|--------------|-------------|--------------|----------|-------------|--------------------------------|--|-----------|
| 0.45              |                          | ņ.       | . 7         | MICI         |             | Α            |          |             |                                |  |           |
| 38. FIELD OF V    | IEW                      |          | 3           | 9. GROU      | ND SWATH    |              | b        | Þ           |                                |  |           |
| 80.0              |                          |          |             |              | M DIAM      | CIRCI        | LE FR    | OM 60       | O NM                           | ALTITUDE   | =         |
| 40. ANGULAR RES   | DLUTION 41.              | SPATIAL  | RESOL       | UTION        |             | *.           |          |             |                                |  |           |
| 33                | DEG 3.                   | 5 NM     | FRO         | 4 600        | NM AL       | TITUD        | Ε        |             |                                |  |           |
| 42. POINTING ACCU | JRACY 43. PC             | DINTING  | RATE        |              | 14. ALTITU  |              |          | INCLINA     |                                |  |           |
|                   |                          |          |             |              | MED E       | CCENT        | RICH     | [GH         |                                | RETROGRA   | ADE       |
| 46. SPECIAL RE    | QUIREMEN                 | TS       |             |              |             | <del> </del> |          |             |                                |  |           |
|                   |                          |          |             |              |             |              |          |             |                                |  |           |
| 47. COMPONEN      |                          |          | 1.000       |              | *           |              | *        |             | e a distance to a speciment of | dis China administrativa and an amendal place and an |           |
| 400 PRIS          |                          | _        |             |              |             |              |          | 1           | v nowen                        |  |           |
| 48. WEIGHT        | 49. VOLUMI               | <u> </u> |             |              | AGE POWER   | 4            | BY POWER |             | K POWER                        | 53. MTBF   |           |
| 54. INTERFERENCE  | 55. MAGNETI<br>INTERFERE | ic       | 56. NUC     | NONE.        | 57. THER    | NONE         | Eo Ciur  | NONE        |                                |  | . 1       |
| NONE              | NONE                     | NCE      | NONE        |              | 37. INTERFE | RENCE        | 58. SHIE | LDING       |                                |  | <u> </u>  |
| 59. CALIBRATIO    |                          |          | NONE        |              | TA RECOV    | EBV          |          | 61 505      | OLIENCY OF                     | OBSERVATION  |           |
| NONE              |                          |          |             | NONI         |             | ENT          | ·        |             | SCHED                          |  |           |
| 62. TELEMETRY     | Y REQUIREM               | MENTS    |             | Livio ivi    | -           | <del></del>  | •        | 1 7 3       | JUITE DY                       | <u> </u>   | and i the |
| NONE              |                          |          |             |              |             |              |          | <del></del> | -                              |  | 1         |
|                   |                          |          |             |              |             |              |          |             |                                |  |           |
|                   |                          |          |             |              |             |              |          |             |                                |  |           |
| 63. ADVANTAG      | ES AND LIM               | ITATIO   | NS          |              |             | 112          |          |             |                                |  |           |
|                   |                          |          | ····        |              |             |              |          |             |                                |  |           |
|                   |                          |          |             |              |             |              |          |             |                                |  |           |
| 64. REFERENCE     | S ·                      |          |             |              |             |              |          |             | 10010 T                        |  |           |
| 1)NASA PI         | RESS KI                  | T FOR    | R GEO       | S-B.         | RELEA       | SE NO        | 68-2     | (, JAI      | V 7, 6                         | 58.***21   | )         |
| PLAN OF (         | OPERATI                  | ONS 1    | FOR 1       | THE G        | EOS-B       | SPACE        | CRAFT    | REP         | ORT NO                         | 3. R-403   | 35-       |
| 45-2, CO          |                          |          |             |              |             |              |          |             |                                |  |           |
| ANALYSIS          | FOR FU                   | TURE     | GEO         | DETIC        | SPACE       | CRAFT        | DEVEL    | OPME        | NT. RE                         | EPORT NO   | ).:       |
| R-4035-50         | 2-2, CO                  | MMUN     | ICATI       | IONS A       | AND SY      | STEMS        | INC,     | JAN 6       | 58.                            |  |           |
| SE MISTORIOA      | DEMARKO                  |          |             |              |             |              |          |             |                                |  |           |
| 65. HISTORICAL    |                          |          |             |              |             |              |          |             |                                |  |           |
| ALSO FLO          | IN UN E                  | XPLO     | K EK 2      | 22,          | 21, AN      | D 29.        | GEUS     | 2 = 1       | XPLO                           | RER 36.  |           |
|                   |                          |          |             |              |             |              |          |             |                                |  |           |
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# INSTRUMENT RESUME NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT MD 20771

|                      |                   | (      | GREENBELT, MD   | . 20  | 771          |                   |       |                 |                  |         |      |                 |
|----------------------|-------------------|--------|-----------------|-------|--------------|-------------------|-------|-----------------|------------------|---------|------|-----------------|
| 1. TITLE             |                   |        |                 |       |              |                   |       |                 | 2. ACR           | ONYM    | 3. E | XP NO           |
| LASER RET            | TROREFLECTOR      |        |                 |       |              |                   |       |                 | LRE              | F       |      |                 |
| (TITLE CONT.         | )                 |        |                 |       |              |                   |       |                 | 4. RESUI         | NE DATE |      | 5.<br>VERSION   |
|                      |                   |        |                 |       |              |                   |       |                 | 09/              | 01/7    |      | 0001            |
| 6. PRINCIPAL IN      | IVESTIGATOR       | 7. OR  | GANIZATION      |       |              |                   | 8. T  | ELEP            | EPHONE           |         |      |                 |
| PLOTKIN,             | H.H.              | GODE   | DARD SPACE      | FL    | r c          | ENTER             | 30    | 1-9             | 82-              | 5042    | 2    |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR | SANIZATION      |       |              |                   | 11. 1 | FELEF           | HONE             |         |      |                 |
| MINOTT, I            | P.0.              | GODI   | DARD SPACE      | FLI   | [ ]          |                   |       |                 |                  | 5042    |      |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX | NUM   | BER          | 15. START<br>DATE | 16.   | COMPLET<br>DATE | ION 17           | . STAT  | US   |                 |
|                      |                   |        |                 |       |              |                   |       |                 |                  |         |      |                 |
| 18. MONITOR          |                   | 19. AG | ENCY            | 2     | 0. PG        | M OFFICE          |       |                 | PHON             |         |      |                 |
| DILLER, (            | D.S.              | NASA   | HDQTRS          |       | ) <u>A</u> / | 'ES               | 20    | 2-7             | '55 <del>-</del> | 2322    | 2    |                 |
| 22. VENDOR           |                   |        | 23. LOCATION    |       |              |                   |       | 24. FI          | LIGHT<br>ATE     | 25. L   | EAD  | TIME            |
| APL ASSE             | MBLING RFLCT      | ~      |                 |       |              |                   |       |                 |                  |         |      |                 |
| 26. INSTRUMEN        | T TYPE            |        |                 |       |              |                   |       |                 |                  |         |      | 27.<br>SECURITY |
| REFLECTO             | 270 CUBE (        | CORNE  | R REFLECTO      | R S   | -            | 35 MM             | AC    | ROS             | SF               | LATS    | 5    | UNC             |
| 28. APPLICATIO       | N                 |        |                 |       |              | 29. SPACE         | CRAI  | FT              |                  |         |      |                 |
| GEOD                 |                   |        |                 |       |              | GEOS-             | -C    |                 |                  |         |      |                 |
| 30. PURPOSE          |                   | , .    |                 |       |              |                   |       |                 |                  |         |      |                 |
| PRIMARY              | - SUPPORT IN      | VES    | TIGATIONS S     | SUCF  | 1 4          | S POLA            | AR    | MOT             | ION              | , FA    | \UL  | T               |
| MOTTON               | - A O T           | 341 A  | ATC PACTI       | T T T |              |                   | ~~    | ALT F           |                  | T       |      |                 |

MOTION, EARTH ROTATION RATE, EARTH TIDES, AND CONTINENTAL DRIFT THEORY.\*\*\* SECONDARY - CONTRIBUTE TO CALIBRATION, DATA ACCURACY DETERMINATION, AND INPROVEMENT OF CANDIDATE TRACKING SYSTEMS.

#### 31. PRINCIPLES OF OPERATION

WHEN THE SATELLITE IS WITHIN RANGE AND 15 OR MORE DEGREES ABOVE THE HORIZON THE REFLECTOR ARRAY REFLECTS BACK TO THE SOURCH LASER TRACKING SYSTEMS. THE LASER ARRAY GEOMETRY SHAL6 BE DESIGNED AND ATTITUDE PASSIVELY CONTROLLED SUCH THAT DURING THE USEFUL ORBIT LIFETIME (10-20 YEARS) THE MAXIMUM ERROR IN THE FIRST REFLECTION POINT OF THE ARRAY RELATIVE TO THE CENTER OF GRAVITY OF THE S/C DOES NOT CAUSE MORE THAN A 5 CM ERROR IN THE RANGE MEASUREMENT ASSUMING AN INFINITELY NARROW PULSE. THE LASER ARRAY IS TO BE CONFIGURED ON THE LATERAL SURFACE OF A CONIC FRUSTRUM WITH THE LATERAL SURFACE ADJOINING THE BOTTOM SURFACE AT A 45 DEGREE ANGLE.

| 32. PHENOMENA OBSERVED     |       |       |      |
|----------------------------|-------|-------|------|
|                            |       |       |      |
| 33. MEASUREMENT RANGE      |       | •     |      |
| 34. PRECISION AND ACCURACY |       |       | <br> |
| RANGE MEASUREMENT GOAL     | IS 10 | C CM. |      |

| 35. SPECTRAL RANGE   | 4                      |          |                  |          | 36.      | SPECTRA   | L RES  | OLL  | JTION   | 37. TIME  | CONSTANT                               |
|--|------------------------|----------|------------------|----------|----------|-----------|--------|------|---------|-----------|--|
| 0.45   | ro c                   | . 7      | MI               | CRON     |          | NΑ        |        |      |         |           |  |
| 38. FIELD OF VIEW  |                        |          | 39. GRO          | UND SWA  | \TH      |           |        |      |         |           |  |
| FROM 15 DEG  |                        |          |                  |          |          |           |        |      |         |           |  |
| 40. ANGULAR RESOLUTION   | 41. SPATIAL            | L RESO   | LUTION           |          |          |           | ·      |      |         |           |  |
|  |                        |          |                  |          |          |           |        | ,    |         |           |  |
| 42. POINTING ACCURACY  | 43. POINTING           | RATE     |                  | 44. ALT  |          |           |        |      | NCLINA  |           |  |
|  |                        |          |                  | 921      | KM       | (MEAN     |        | 11   | 5 DE    | GREE S    | <del>-</del>                           |
| 46. SPECIAL REQUIRE  | MENTS                  | ···      |                  |          |          |           |        |      |         |           |  |
| 47. COMPONENTS   | TAMES AND ASSESSED AS  |          | <del></del>      |          |          |           |        |      |         |           |  |
| MIN 270 CUBE   | CORNER                 | REF      | FET              | npc      |          |           | -      |      |         |           |  |
| <del></del>  | DLUME                  | . 176.1  |                  | RAGE POW | co       | 51. STAND | RY POW | en l | 52 PFA  | K POWER   | 53. MTBF                               |
| The second of th | NE INTER               | NAL      | <u> </u>         | ONE      |          | NON       |        |      | NON     |           | <u> </u>                               |
|  | MAGNETIC<br>TERFERENCE |          | CLEAR<br>FERENCE | 57. INT  | HERMA    |           |        | HIEL | DING    | -         | <u> </u>                               |
| NONE   | NONE                   | •        | NE               |          |          |           |        |      |         |           | <del>_</del>                           |
| 59. CALIBRATION  |                        |          | 60. D            | ATA REC  | OVE      | RY        |        |      | 61. FRE | DUENCY OF | DBSERVATION                            |
| NONE   | NONE                   | NC       | INE              |          |          |           |        |      | AS      | SCHEDU    | LED                                    |
| 62. TELEMETRY REQU   | JIREMENTS              | -        |                  |          |          |           |        |      |         |           | ************************************** |
| NONE   |                        |          |                  |          |          |           | -      |      |         |           |  |
|  |                        |          |                  |          |          |           |        |      |         |           |  |
|  |                        |          | -:               |          |          |           |        |      |         |           |  |
| 63. ADVANTAGES AN  | D LIMITATIO            | NS       |                  |          |          |           |        |      |         |           | gyna wal                               |
|  |                        |          |                  |          |          |           |        |      |         |           |  |
|  |                        | ,        |                  |          |          | •         |        |      |         |           |  |
| 64. REFERENCES   | CCDACT                 | <u> </u> | OTME             | W 0 C    | <u> </u> | O C M C   | N.T.C  | 0.3  | CUME    | UT DE     |  |
| GEOS-C SPAC  |                        | בארכ     | K IME            | NI KE    | AOI      | IKEME!    | 14 1 2 | נט   | CUME    | NI 9 KE   | V 1,                                   |
| 12 MAT 1972  | •                      |          |                  | •        |          |           |        |      |         |           |  |
|  |                        |          |                  |          |          |           |        |      |         |           |  |
|  |                        |          |                  |          |          |           |        |      |         |           |  |
|  |                        |          |                  |          |          |           |        |      |         |           |  |
| 65. HISTORICAL REMA  | ARKS                   |          |                  |          |          |           |        |      |         |           |  |
| IMPROVED VER   | SION OF                | GEO      | )S 2             | LASER    | RE       | FLEC      | TOR    |      | :       |           |  |
|  |                        |          |                  |          |          |           |        |      |         |           |  |
| 1  |                        |          |                  |          |          |           |        |      |         |           |  |
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|  |                        |          |                  |          |          |           |        |      |         |           |  |

# INSTRUMENT RESUME NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT MD 20771

|                      |                 |        | GREENBELT, MD   | . 20771       |                   |              |                    |            |   |                 |
|----------------------|-----------------|--------|-----------------|---------------|-------------------|--------------|--------------------|------------|---|-----------------|
| 1. TITLE             |                 |        |                 |               |                   |              | 2. A               | CRONYM     | 3. E                                    | XP NO           |
| RADAR AL             | TIMETER         |        |                 |               |                   |              | R A                | \LT        |   |                 |
| (TITLE CONT          | T.)             |        | XIVI,           |               |                   |              | 4. RI              | ESUME DATE |   | ERSION          |
|                      |                 |        |                 |               |                   |              | 0.9                | 9/01/      | 72                                      | 2001            |
| 6. PRINCIPAL         | INVESTIGATOR    | 7. OR  | GANIZATION      |               |                   | 8. T         | ELEPHO             | NE         |   |                 |
| STANLEY              | H.R.            | NAS    | A WALLOPS S     | TATIO         | N                 | 703-824-3411 |                    |            |   |                 |
| 9. CO-INVESTI        | GATOR           | 10. OR | GANIZATION      | 11. TELEPHONE |                   |              |                    |            |   |                 |
|                      |                 |        |                 |               |                   |              |                    |            |   |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NU | MBER   | 14. FLASH INDEX | NUMBER        | 15. START<br>DATE | 16. C        | OMPLETION<br>DATE  | 17. STAT   | US                                      |                 |
|                      |                 |        |                 |               |                   |              |                    |            |   |                 |
| 18. MONITOR          |                 | 19. AG | ENCY            | 20. PGA       | OFFICE            | 21. 1        | ELEPHO             | DNE        |   |                 |
| DILLER,              | 0.5.            | NAS    | A HDQTRS        | 047           | ES                | 20           | 2-755              | 5-2322     | 2                                       |                 |
| 22. VENDOR           |                 |        | 23. LOCATION    |               |                   | · •          | 24. FLIGHT<br>DATE | 25. L      | EAD                                     | TIME            |
|                      |                 |        |                 |               | -                 |              | 6/74               | +          |   |                 |
| 26. INSTRUME         | NT TYPE         |        |                 |               |                   |              |                    |            |   | 27.<br>SECURITY |
| PADAR AL             | TIMETER         |        | <del>=</del> :  |               | •                 |              | -                  |            |   | UNC             |
| 28. APPLICATI        | ON              |        |                 | 1             | 29. SPACE         | CRAF         | T                  |            |   |                 |
| GEOD                 |                 |        |                 |               | GEOS              | С            |                    |            |   |                 |
|                      |                 |        |                 |               |                   |              |                    |            | *************************************** |                 |

#### 30. PURPOSE

PRIMARY - DEMONSTRATE FEASIBILITY AND UTILITY TO MAP
TOPOGRAPHY GLOBAL SEA SURFACE. \*\*\* SECONDARY - DEVELOP
TECHNOLOGY LEADING TO ULTIMATE SYSTEM WITH 10 CM CAPABILITY.

#### 31. PRINCIPLES OF OPERATION

WITH SUITABLE ALTIMETRY AND SUFFICIENT ACCURACY IN DETERMINATION OF THE GEOCENTRIC POSITION OF THE SPACECRAFT THE GEOMETRY OF THE OCEAN SURFACE CAN BE DESCRIBED AND MEAN SEA LEVEL DETERMINATIONS MADE. COMMAND TRANSMISSIONS IN THE STADAN REGION OF 148.2 TO 154.2 MHZ FOR MODE SELECTION AND LOW-NOISE RECEIVER IN/OUT. TELEMETRY IN THE 136 TO 137 MHZ RANGE FOR MODE AND MEASUREMENT INFORMATION AND HOUSEKEEPING. GLOBAL MODE MAX DAILY SCHEDULE OF 8-30 MIN OPERATIONS, EACH SEPERATED BY ONE HOUR.

#### 32. PHENOMENA OBSERVED

TIME-VARYING OCEAN SURFACE AND QUASI-STEADY STATE DEPARTURES.

#### 33. MEASUREMENT RANGE

### 34. PRECISION AND ACCURACY

ABSOLUTE, PLUS/MINUS 5 METER: RELATIVE, PLUS/MINUS 1 METER.

| 35. SPECTRAL     |                   | E  |        |                        |          | 36.  | SPECTRA     | AL RES   | SOLL        | JTION        | 37. TIME                              | CONSTANT   |
|------------------|-------------------|--|--------|------------------------|----------|------|-------------|----------|-------------|--------------|---------------------------------------|--|
| 13.9 GHZ         |                   |  |        |                        | ,        |      |             |          |             |              |                                       |  |
| 38. FIELD OF     | VIEW              |  |        | 39. GRO                | UND SWA  | TH   |             |          |             |              |                                       |  |
|                  |                   |  |        |                        |          |      |             |          |             |              |                                       |  |
| 40. ANGULAR RE   | SOLUTIO           | N 41. SPATIA   | L RESO | LUTION                 |          |      | •           |          |             |              |                                       |  |
|                  |                   |  |        |                        |          |      |             |          |             |              |                                       |  |
| 42. POINTING ACC | URACY             | 43. POINTING   | RATE   |                        | 44. ALT  |      |             |          |             | NCLINA       |                                       |  |
| 2                |                   |  |        |                        | 927 K    | (M ( | MEAN        |          | 11          | 5 DEG        | REES                                  |  |
| 46. SPECIAL R    |                   |  |        |                        |          |      |             | · ,,,,,, | ,           | 2.10         | ,,                                    |  |
| TEMP LI          | MITS              | (ELECT   | PONI   | CS) M                  | IINUS    | 10   | ) TO F      | LUS      | 4 (         | DEG          | C .                                   |  |
| 47. COMPONE      | NTS               | THE STREET STREET, STR |        | miningly in the second |          |      |             |          |             |              |                                       |  |
|                  |                   |  |        |                        |          |      |             | -        |             | ,            |                                       |  |
| 48. WEIGHT       | 49. V             | OLUME  |        | 50. AVE                | RAGE POW | ER   | 51. STAND   | BY POW   | ER          | 52. PEA      | K POWER                               | 53. MTBF   |
| 85               |                   | 0.4  |        |                        |          |      |             |          |             | 100          |                                       |  |
| 54. INTERFERENCE | 55. <sub>IN</sub> | MAGNETIC<br>ITERFERENCE  | 56. NU | CLEAR                  | 57. INTE | HERM | AL<br>ENCE  | 58. SI   | HIEL        | DING         |                                       |  |
|                  | <del> </del>      | - Citation   |        | , cherce               |          |      |             |          |             |              |                                       |  |
| 59. CALIBRAT     | ION               |  | 1      | 60. D                  | ATA REC  | OV   | FRY         | <u> </u> |             | 61. FRE      | DUENCY OF                             | DBSERVATION  |
|                  |                   |  |        | 1                      |          |      |             | ,        |             |              | <del></del>                           | OBS/DAY  |
| 62. TELEMETE     | Y REO             | UIREMENTS  |        |                        |          |      |             |          |             | 1            | O DIN                                 | OUS/ DAT   |
|                  |                   |  |        |                        |          |      |             |          |             | <del> </del> | · · · · · · · · · · · · · · · · · · · |  |
| SEE I            | TEM               | 31   | •      |                        |          |      |             |          |             |              |                                       |  |
| 63. ADVANTA      | GES AN            | D LIMITATIO  | NC ·   | <del></del>            |          |      |             |          |             |              |                                       |  |
| 33. AUVANIA      | UES AN            | LIMITATIO  | 142    |                        |          |      |             | *        |             |              |                                       |  |
|                  |                   |  |        |                        |          |      |             |          |             |              |                                       |  |
|                  |                   |  |        |                        |          |      |             |          | <del></del> | •            | р п пам                               | <del> </del>   |
| 64. REFERENC     | ES                |  |        |                        |          |      |             | •        |             |              |                                       |  |
| GEOS-C<br>12 MAY | SPAC<br>1972      | ECRAFT E   | XP E   | RIMEN                  | T REQ    | UI   | REMEN       | TS (     | 000         | UMEN         | T, REV                                | ( 1 ,  |
| 65. HISTORICA    | AL REM            | ARKS   |        |                        |          |      | <del></del> |          |             |              |                                       | and the state of t |
|                  |                   |  |        |                        |          |      |             |          |             |              |                                       |  |
|                  |                   |  |        |                        |          |      |             |          |             | ,            |                                       |  |
| ·                |                   |  |        |                        |          |      |             |          |             |              |                                       |  |
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|                  |                   |  |        |                        |          |      |             |          |             |              |                                       |  |
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| l                |                   |  |        |                        |          |      |             |          |             |              |                                       |  |
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## NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT MD 20771

|                      |                   |        | GREENBELT, MC     | D. 20 | 771     |                   |          |                    |            |                  |               |
|----------------------|-------------------|--------|-------------------|-------|---------|-------------------|----------|--------------------|------------|------------------|---------------|
| 1. TITLE             |                   |        |                   |       |         |                   |          | 2. 4               | CRONYM     | 3. E             | XP NO         |
| SATELLIT             | E RADIO BEAC      | ON E   | XPER IMENT        |       |         |                   |          | SF                 | ₹BE        |                  |               |
| (TITLE CONT.         | )                 |        |                   |       |         |                   |          | 4. R               | ESUME DATE |                  | 5.<br>VERSION |
|                      |                   |        |                   |       |         |                   |          | 0.9                | 7/01/      |                  | 0002          |
| 6. PRINCIPAL II      | NVESTIGATOR       | 7. OR  | GANIZATION        |       |         |                   | 8. TI    | ELEPHO             | NE         |                  |               |
| DAVIES,              | Κ.                | ESS    | A-BOULDER,        | CO    | L.      |                   | 303      | 3-447              | 7-1000     | <del>ر</del><br> |               |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION        |       |         |                   | 11. T    | ELEPHO             | NE.        |                  |               |
|                      |                   |        |                   |       |         |                   | <u> </u> |                    |            |                  |               |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX   | NUM   | BER     | 15. START<br>DATE | 16. C    | OMPLETION<br>DATE  | 17. STAT   | rus              |               |
|                      |                   |        | <u> </u>          |       |         |                   |          |                    |            |                  |               |
| 18. MONITOR          |                   | 19. AG | ENCY              | 2     | 20. PGM | OFFICE            | 21. T    | ELEPHO             | ONE        |                  |               |
| BURKE, J             | .R.               | NAS    | A HDQTRS          |       | CA/     | <u>EĆS</u>        | 20       | 2-755              | -232       | 2                |               |
| 22. VENDOR           |                   |        | 23. LOCATION      |       |         |                   |          | 24. FLIGHT<br>DATE | 25. L      | EAD              | TIME          |
| 26. INSTRUMEN        | TTYPE             |        |                   |       |         |                   |          |                    |            |                  | 27.           |
|                      |                   |        | . = 0 = 1 \ . = 0 |       |         |                   |          |                    |            |                  | SECURITY      |
|                      | TRANSMITTER .     | AND 1  | RECEIVER          | ····  |         |                   |          |                    |            |                  | LUNC          |
| 28. APPLICATIO       |                   |        |                   |       | 2       | 9. SPACE          | CRAF     | T                  |            |                  |               |
| IONOSPHE             | RES AND RADIO     | H9 C   | YSICS_            |       |         | ATS-F.            | /G       |                    |            |                  |               |
| 30. PURPOSE          |                   |        |                   |       |         |                   |          |                    |            |                  |               |
| PRIMARY-             | TO STUDY ION      | SPH    | ERIC AND EX       | XO SI | PHE     | RIC P             | ROCE     | ESSES              | THRO       | DUG              | Н             |
| RADIO TR             | ANSMISSIONS :     | SUIT   | ABLE FOR FA       | ARA   | DAY     | ROTA              | TIO      | N AND              | DIF        | EP               | ENT-          |

PRIMARY-TO STUDY IONOSPHERIC AND EXOSPHERIC PROCESSES THROUGH RADIO TRANSMISSIONS SUITABLE FOR FARADAY ROTATION AND DIFFERENT-IAL GROUP DELAY MEASUREMENTS \*\*\*SECONDARY-MAKE COHERENT PHASE SCINTILLATION MEASUREMENTS AND PROVIDE A SOURCE FOR ACCURATE MEASUREMENTS OF IONOSPHERIC ABSORPTION AT A SINGLE FREQUENCY.

#### 31. PRINCIPLES OF OPERATION

RADIO-BEACON TECHNIQUES EXPLOIT THE DISPERSION OF RADIO SIGNALS IN THE PROPOGATION MEDIUM. THERE ARE TWO BASIC APPROACHES. THE PRESENCE OF A LONGITUDINAL MAGNETIC FIELD. THE DISPERSION BETWEEN THE MAGNETO-IONIC COMPONENTS OF A LINEARLY-POLARIZED SIGNAL CAUSE THE PLANE OF POLARIZATION TO ROTATE PROGRESSIVELY AS THE WAVE PROPAGATES. THIS IS THE FARADAY EFFECT, BY WHICH IT IS POSSIBLE TO DETERMINE THE ELECTRON CONTENT (THE NUMBER OF ELECTRONS IN A COLUMN OF UNIT CROSS SECTION) ALONG THE PROPOGA-TION PATH. THE SECOND APPROACH COMPARES THE DISPERSION ON TWO DISTINCT FREQUENCIES. FOR INSTANCE, IF TWO PHASE-RELATED SIG-NALS ARE TRANSMITTED, A MEASUREMENT OF THE RELATIVE CHANGE OF PHASE BETWEEN THE TWO SIGNALS RECEIVED AT A DISTANT POINT GIVES THE ELECTRON CONTENT ALONG THE PROPOGATION PATH. THIS IS THE PHASE-PATH METHOD, OFTEN CALLED DIFFERENTIAL DOPPLER, AND IT IS INDEPENDENT OF THE AMBIENT MAGNETIC FIELD. THE ESSENCE OF THE BEACON TECHNIQUE FOR EXOSPHERIC STUDIES IS TO MEASURE THE IONO-SPHERIC ELECTRON CONTENT BY THE FARADAY METHOD, AND TO SUBTRACT ONE FROM THE OTHER TO ARRIVE AT THE ELECTRON CONTENT OF THE **EXOSPHERE.** 

#### 32. PHENOMENA OBSERVED

PHASE DIFFERENCE&POLARIZATION ROTATION OF VHE&UHF RADIO SIGNALS

#### 33. MEASUREMENT RANGE

NA

#### 34. PRECISION AND ACCURACY

0.05 CYCLE IN A 1 MHZ DIFFERENCE SIGNAL

| 35. SPECTRAL RANGE                     |                     |           | 36. SPECTR          | AL RE                                  | SOLUTION   | 37. TIME | CONSTANT             |
|--|---------------------|-----------|---------------------|--|------------|----------|----------------------|
| NA                                     |                     |           | NΔ                  |  |            |          |                      |
| 38. FIELD OF VIEW                      | 39. GRO             | UND SWA   | ТН                  |  |            |          |                      |
| NA                                     | , ·                 | AV        |                     |  |            |          |                      |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES | OLUTION             |           |                     |  |            |          |                      |
| NA NA                                  |                     |           |                     |  |            |          |                      |
| 42. POINTING ACCURACY 43. POINTING RAT | <b>E</b>            | 44. ALTI  | TUDE                |  | 45. INCLIN | ATION    |                      |
|  |                     |           |                     |  |            |          |                      |
| 46. SPECIAL REQUIREMENTS               |                     |           | <u> </u>            |  |            | ·        | ſ                    |
| · · · · · · · · · · · · · · · · · · ·  |                     |           |                     | <u> </u>                               | 40         |          |                      |
| 47. COMPONENTS                         |                     |           |                     |  |            |          |                      |
| TRANSMITTER, ANTENNA,                  |                     |           |                     |  |            |          |                      |
| 48. WEIGHT 49. VOLUME                  |                     |           | ER 51. STAND        | OBY POV                                | VER 52. PE | AK POWER | 53. MTBF             |
| 5 LB                                   |                     | 5 WAT     | HERMAL<br>ERFERENCE | Teo e                                  |            |          | <u> </u>             |
|  | WCLEAR<br>ERFERENCE | 57. INTE  | RFERENCE            |  | HIELDING   | CTIC C   | UTELDING             |
| SOURC/SEN SENSITIVE                    | 160 D               | ATA REC   | OVERV               | IKE                                    |            |          | HIELDING OBSERVATION |
| NA                                     |                     |           | E TELEM             | ETD                                    |            | COMMAN   |                      |
| 62. TELEMETRY REQUIREMENTS             | IKE                 | AL I I TI | - ICLEM             | C IK                                   | איטן י     | CUMMAN   | ·                    |
| ALL FREQUENCIES DERIVE                 | D ERUM              | 4 Δ 1     | MH7 SO              | HRC                                    | FOR        | FARAD    | AY MEAS-             |
| UREMENTS: 200 HZ BANDW                 |                     |           |                     | Unti                                   | -          | TANAU    | 71 MLM3"             |
|  | _                   |           |                     |  |            |          |                      |
| 63. ADVANTAGES AND LIMITATIONS         |                     |           |                     | ······································ |            |          | J                    |
|  |                     |           |                     |  |            |          |                      |
|  |                     |           |                     |  |            |          |                      |
| 64. REFERENCES                         |                     |           |                     |  |            | ··· -    |                      |
| 1) GRUBB, R. N., ATS-F                 |                     | ON TRA    | ANSMITT             | ER A                                   | AND REC    | EIVING   | SYSTEMS              |
| ENGINEERING CONSIDERAT                 | IONS                |           |                     |  |            |          |                      |
|  |                     |           |                     |  |            |          | [                    |
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|  |                     |           |                     |  |            |          | J                    |
| 65. HISTORICAL REMARKS                 |                     |           |                     |  |            |          |                      |
| BO. HISTORICAL REMARKS                 |                     | <u> </u>  |                     |  |            |          |                      |
|  |                     |           |                     |  |            |          |                      |
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## **RADIOMETERS**

#### INSTRUMENT RESUME NATIONAL AERONAUTICS AND SPACE ADMINISTRATION **GODDARD SPACE FLIGHT CENTER** CREENBELT MD 20771

|              |            | GREENBELT, ND. 20 |         |            |
|--------------|------------|-------------------|---------|------------|
| 1. TITLE     |            |                   |         | 2. ACRONYM |
| EXPERIMENTAL | 24-CHANNEL | MULTISPECTRAL     | SCANNER | ECMSS      |

3. EXP NO

| (TITLE CONT.)             |                          | 4. RESUME DATE VERSION |
|---------------------------|--------------------------|------------------------|
|                           |                          | 03/04/71 0002          |
| S. PRINCIPAL INVESTIGATOR | 7. ORGANIZATION          | 8. TELEPHONE           |
| KORB,C.C.                 | MANNED SPACECRAFT CENTER | 713-483-3111           |
| 9. CO-INVESTIGATOR        | 10. ORGANIZATION         | 11. TELEPHONE          |
|                           |                          |                        |
|                           | 15 07407                 | COMPLETION             |

| TYPE        | 13, CONTRACT RUMBE | n 14. FLMSH IN | DEX MONIBER | DATE   | DATE       | 17.01710 | ,     |
|-------------|--------------------|----------------|-------------|--------|------------|----------|-------|
|             |                    |                |             | 10/68  | 06/71      | FINAL    | TESTS |
| 18. MONITOR |                    | 9. AGENCY      | 20. PGM     | OFFICE | 21. TELEPH | ONE      |       |
| CLEMENCE    | , R.               | MSC            |             |        |            |          | -     |

23. LOCATION 24. FLIGHT DATE 25. LEAD TIME 22. VENDOR BENDIX CORPORATION ANN ARBOR, MICHIGAN

**26. INSTRUMENT TYPE** SECURITY RADIOMETER (SCANNING) UNC

28. APPLICATION 29. SPACECRAFT ERSP C-130 A/C

30. PURPOSE

PRIMARY-TO ACQUIRE AND RECORD MULTISPECTRAL SCANNING DATA OF THE EARTH'S TERRAIN IN SEPERATE SPECTRAL BANDS IN A TIME-AND-SPACE-COINCIDENT MANNER\*\*\*SECONDARY-TO ESTABLISH THE VARIOUS SPECTRAL BANDS THAT PROVIDE USEFUL INFORMATION IN THE GEOLOGY, HYDROLOGY, OCEANOGRAPHY, AND AGRICULTURAL DISCIPLINES.

#### 31. PRINCIPLES OF OPERATION

THE RADIOMETER USES AN ALL REFLECTIVE SYSTEM. A 45-DEG MIRROR SCANS CROSS-TRACK WHILE THE A/C FORWARD MOTION GIVES THE SECOND DIMENSION. THE MIRROR RATE IS SELECTED TO GIVE CONTIGUOUS LINES ACROSS THE TERRAIN. THE SPECTRAL BANDS ARE FORMED BY DETECTOR ARRAYS IN THE FOCAL PLANE OF TWO GRATING SPECTROMETERS. THE DET-ECTORS INCLUDE P/M TUBES, SI AND GE PHOTODIODES, IN-SB PHOTOVOL-TAIC CELLS AT 77 DEG.K, AND HG DOPED GE AT 25 DEG.K. DURING IN-ACTIVE PART OF SCAN, THE TOTAL OPTICAL SYSTEM VIEWS FIELD FILLING CALIBRATION SOURCES TO CALIBRATE OUT CHANGES IN OPTICAL TRANS-MISSION CHARACTERISTICS. TWO THERMOELECTRICALLY CONTROLLED BLACK BODIES ARE USED FOR THE THERMAL AND REFLECTIVE BANDS. ONE CALI-BRATION SOURCE IS EITHER A UV/VIS./NEAR-IR OR "SKYLIGHT" REFER-ENCE.THE SIGNAL FROM A DETECTOR IS AMPLIFIED, THEN PROCESSED INTO AN 8-BIT WORD. A MEMORY BUFFER UNIT REMOVES DEAD TIME IN THE SCAN CYCLE TO GIVE A UNIFORM BIT RATE OUTPUT. TWO CHANNELS ARE MULTIPLEXED AND PLACED ON ONE TRACK OF A 24-TRACK RECORDER. THE 13TH CHANNEL HAS HOUSEKEEPING DATA. THE 24TH HAS THE TIME CODE. THE DATA ANALYSIS GROUND STATION GENERATES (A) SCREENING VIA A 3 COLOR TV DISPLAY, (B) IMAGERY OF 3 SEPERATE BANDS IN B/W OR FALSE COLOR. (C) COMPUTER COMPATIBLE TAPES.

32. PHENOMENA OBSERVED

REFLECTED AND THERMAL RADIATION FROM THE FARTH'S SURFACE 33. MEASUREMENT RANGE

VISIBLE AND INFRARED REGIONS.

34. PRECISION AND ACCURACY

| 0.34              | RANGE         |             |                   |             | 36.       | SPECTRA                               | AL RES                                | OLUTIO  | ON 13   | 37. I INE  | CONSTANT    |
|-------------------|---------------|-------------|-------------------|-------------|-----------|---------------------------------------|---------------------------------------|---------|---------|------------|-------------|
|                   | TO            | 13          |                   | MICR        | ONS       | 24                                    | СН                                    | IANNE   |         |            |             |
| 38. FIELD OF V    | IEW           |             | J                 |             | SWATH     |                                       |                                       |         |         |            |             |
| NA                |               |             |                   |             | SCAN      | ANGL                                  | E                                     |         |         |            |             |
| 40. ANGULAR RES   |               | TIAL RES    | OLUT              | ION         |           | •                                     |                                       |         |         |            |             |
| 0.114             |               |             |                   |             |           |                                       |                                       |         |         | ·····      |             |
| 42. POINTING ACCL | RACY 43. POIN | TING RAT    | Ė                 |             | ALTITU    |                                       |                                       | 45. INC | LINAT   | ION        |             |
| NA .              |               |             | Na                | 11          | • 5K T    | 0 30K                                 | FT                                    |         |         |            |             |
| 46. SPECIAL RE    | QUIREMENTS    |             |                   |             |           |                                       |                                       |         |         |            |             |
| 47 00400151       |               |             |                   | <del></del> |           |                                       |                                       |         |         |            |             |
| OPTICS,           |               | CDA         | TTN               | C E         | ECTD      | ONICC                                 |                                       |         |         |            |             |
|                   | 49. VOLUME    | , GRA       |                   |             |           | 51. STAND                             |                                       | ED 52   | DEAK    | POWER      | 53. MTBF    |
| 46. WEIGHT        | 49. VOLOWIE   |             | +30               | AVERAG      | EFONER    | 31.317.00                             | 817011                                | ER JE.  | LLAN    | · OHER     | 33. WITST   |
| 54. INTERFERENCE  | 55. MAGNETIC  | 56.         | NUCLEAR<br>ERFERE |             | 57. THERM | AL                                    | 58 SI                                 | HIELDIN | VG      |            |             |
| MIENTEREME        | INTERPERENCE  | 1741        | ENFERE            | VCE         | INVERTER  | ENCE                                  | 00.0                                  |         |         | ~          |             |
| 59. CALIBRATI     | DN            |             | 10                | 60. DAT     | A RECOV   | ERY                                   | 1                                     | 61      | . FREQI | JENCY OF C | DBSERVATION |
| INTERNAL          | LY (SEE 1     | TEM 3       | 1)                | FROM        | RETU      | RNED                                  | TAPE                                  | S C     | ONT     | INUOU      | S           |
| 62. TELEMETR      | <del></del>   | <del></del> |                   |             |           |                                       |                                       | - 1 -   |         |            |             |
| NA                |               |             |                   |             |           |                                       |                                       |         |         |            |             |
|                   |               |             |                   |             |           |                                       |                                       |         |         |            |             |
|                   |               |             |                   |             |           |                                       |                                       |         |         |            |             |
| 63. ADVANTAG      |               |             |                   |             |           |                                       |                                       |         |         |            |             |
| DATA CAN          | BE PROCE      | SSED        | IN                | LARG        | E-SCA     | LE DI                                 | GITA                                  | L CO    | MPU     | TERS.      |             |
|                   |               |             |                   |             |           |                                       |                                       |         |         |            |             |
| 64. REFERENCI     |               |             |                   | ***         |           | ==                                    |                                       |         |         |            |             |
|                   | , E. M, E     |             |                   |             |           |                                       |                                       |         |         |            |             |
| MULTISPE          |               | INNER       | 2 <b>4</b> 2      | IEM,        | REND      | IX 1E                                 | CHNI                                  | CAL     | 100     | RNAL,      | SUMMER/     |
| AUTUMN 1          | 970.          |             |                   |             |           |                                       |                                       |         |         |            |             |
|                   |               |             |                   |             |           |                                       |                                       |         |         |            |             |
|                   | <b>V</b>      |             |                   |             |           |                                       |                                       |         |         |            |             |
| 65. HISTORICA     | L REMARKS     |             |                   |             | ····      |                                       |                                       |         |         |            |             |
|                   |               |             |                   |             |           | · · · · · · · · · · · · · · · · · · · | · · · · · · · · · · · · · · · · · · · |         |         |            |             |
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### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION **GODDARD SPACE FLIGHT CENTER**

|                      |                   |        | GREENBELT, MD. 2   | 20771   |                   |       |                    |            |     |                 |
|----------------------|-------------------|--------|--------------------|---------|-------------------|-------|--------------------|------------|-----|-----------------|
| 1. TITLE             |                   |        |                    |         |                   |       | 2. /               | ACRONYM    | 3.  | EXP NO          |
| EARTH RAD            | DIATION BUDGE     | ET     |                    |         |                   |       | ER                 | В          |     |                 |
| (TITLE CONT.         | )                 |        |                    |         | <u> </u>          |       | 4. R               | ESUME DATE |     | 5.<br>VERSION   |
|                      |                   |        |                    |         |                   |       | 09                 | /01/7      | '2  | 9002            |
| 6. PRINCIPAL II      | NVESTIGATOR       | 7. OR  | GANIZATION         |         |                   | 8. T  | ELEPHO             | NE         |     |                 |
| SMITH, W.            | . L.              | NAT.   | OC. & ATM.         | AGE     | VC Y              |       |                    |            |     |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION         |         | :                 | 11. T | ELEPHO             | NE         |     |                 |
| DRUMMOND,            | , A. J.           | EPPL   | EY LABORATOR       | RIES    |                   |       |                    |            |     |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | MBER    | 15. START<br>DATE | 16. C | OMPLETION<br>DATE  | 17. STA1   | rus |                 |
|                      |                   |        |                    |         |                   | ١ _   |                    | PROPO      | SA  | L               |
| 18. MONITOR          | •                 | 19. AG | ENCY               | 20. PGA | OFFICE            | 21. 7 | TELEPHO            | ONE        |     |                 |
| SCHARDT,             | 3.8.              | NASA   | HDQTRS             | 04/     | ERN               | 202   | 2 <del>-</del> 755 | -2322      |     |                 |
| 22. VENDOR           |                   |        | 23. LOCATION       | _       |                   |       | 24. FLIGHT<br>DATE | .25. L     | EAD | TIME            |
|                      |                   |        |                    |         |                   |       | 197                | 4          |     |                 |
| 26. INSTRUMEN        | T TYPE .          |        | 127                |         |                   |       |                    |            |     | 27.<br>SECURITY |
| RADIOMETE            | R                 |        |                    |         | <u> </u>          |       |                    |            |     | UNC             |
| 28. APPLICATIO       | N                 |        |                    |         | 29. SPACE         | CRAF  | ₹T                 |            |     |                 |
| MET, SOLA            | AR PHYSICS        |        |                    |         | VIMBUS            | -F    |                    |            |     |                 |
| 30. PURPOSE          |                   |        |                    |         |                   |       |                    |            |     |                 |
| PRIMARY-T            | O ASCERTAIN       | EART   | H RADIATION        | BUD     | GET BY            | 1 1   | ) MEA              | SURIN      | G   | IN-             |
| COMING SC            | HAD DADIATIC      | N RE   | THEEN O 2 TO       | 34      | MICE              | ONS   | 5. 21              | MEAS       | LID | ING             |

OUTGOING EARTH REFLECTED AND EMITTED RADIATION IN THE SAME SPEC-TRAL BANDS.

#### 31. PRINCIPLES OF OPERATION

EMITTED AND REFLECTED RADIATION FROM EARTH IS MEASURED IN TWO WAYS: 1) AN INTEGRATION OVER THE ENTIRE EARTH'S DISC MEASURING TOTAL TERRESTRIAL FLUX PASSING THROUGH A UNIT AREA AT SATELLITE ALTITUDE: 2) A SERIES OF MEASUREMENTS OF THE RADIANCE EMITTED AND REFLECTED FROM RELATIVELY SMALL AREAS AT A NUMBER OF ZENITH AND AZIMUTH ANGLES. ANGULAR DISTRIBUTION OF RADIANCE IS DETER-MINED BY A SCAN SYSTEM PROVIDING OBSERVATIONS OF LOCAL ZENITH AND AZIMUTH ANGLES. THE INSTRUMENT INCLUDES A SCANNING RADIOME-TER HEAD WHICH CONTAINS 4 SHORTWAVE AND 4 LONGWAVE CHANNELS WITH 0.25 DEG FOV IN THE SCAN PLANE AND 5 DEG IN THE NORMAL PLANE. SCANNING TAKES PLACE FROM THE NADIR TOWARD THE HORIZON. COVERAGE IN 5 DEG GAPS IS OBTAINED BY ROTATION OF THE HEAD ABOUT A VERTI-CAL AXIS. IN THIS MANNER COVERAGE EXTENDS 20 DEG TO EACH SIDE OF THE NOMINAL SCAN PLANE. FIVE SCAN MODES ARE AVAILABLE UPON COMMAND FROM THE GROUND. SCANS TAKING PLACE AT 22.5, 90 DEG. ETC. FROM THE ORBITAL PLANE ARE ACCOMPLISED BY PERFORMING ADDI-TIONAL ROTATIONS OF THE HEAD ABOUT THE VERTICAL AXIS PRIOR TO THE FIFTH MODE IS A COMPOSITE OF THE FIRST TWO MODES. A COMPLETE SCAN CYCLE IN EACH OF THE FOUR BASIC MODES IS 112 SEC PERMITTING UP TO 9 DIFFERENT VIEWS OF AN INDIVIDUAL AREA.

32. PHENOMENA OBSERVED

INCOMING AND REFLECTED SOLAR RADIATION, TERRESTRIAL RADIATION

33. MEASUREMENT RANGE

JV, VISIBLE, IR TO GREATER THAN 40 MICRONS

34. PRECISION AND ACCURACY

| 35. SPECTRAL RA    | ANGE                 |             |                  |          | 36.          | . SPECTRA   | AL RE  | SOLUTIO  | N        | 37. TIME                               | CONST  | TANT        |
|--------------------|----------------------|-------------|------------------|----------|--------------|-------------|--------|----------|----------|--|--------|-------------|
| 0.2                | TO >40               | •           | MICPONS 112 SE   |          |              |             |        |          |          | FCONDS                                 |        |             |
| 38. FIELD OF VIE   |                      |             | 9. GROL          | JND SWA  | ТН           | *           |        |          |          | ,                                      | -      |             |
|                    |                      |             |                  |          |              |             |        |          |          |  |        |             |
|                    | UTION 41. SPATIAL    | RESOL       | UTION            |          |              |             |        |          |          |  |        |             |
|                    | DEG                  |             |                  |          |              |             |        |          |          |  |        |             |
| 42. POINTING ACCUR | ACY 43. POINTING     | RATE        |                  | 44. ALT  |              |             |        | 45. INCL |          |  |        |             |
|                    |                      |             | 1                | MED-     | CI           | RCULAF      | ₹      | SUN-     | SYN      | ICH RE                                 | TRO(   | GRADE       |
| 46. SPECIAL REO    | UIREMENTS            |             |                  |          |              |             |        |          |          |  |        |             |
| -                  |                      |             |                  |          |              | <del></del> |        |          |          |  |        |             |
| 47. COMPONENTS     |                      | <u> </u>    | * <b>T</b> D O M | 1.00     |              |             |        |          |          |  |        |             |
|                    | R, OPTICS, 9. VOLUME | <u>tttt</u> |                  |          |              | IEL STAND   | DV 001 | E2 G     | DE A I   | / DOWED                                | E2 4   | ATDE        |
| 56 LB              |                      | J FT        |                  | RAGE POW |              | 51. STAND   | BY POV | TER 32.1 | CAI      | CFONER                                 | 53. IV | ATBF        |
| 54. INTERFERENCE   | 55. MAGNETIC         | 56. NUCL    |                  | 57. INT  |              | AL          | 50 C   | HIELDIN  | G        |  |        |             |
| INTERFERENCE       | INTERFERENCE         | INTERF      | EHENCE           | INI      | KFER         | RENCE       | 30. 3  |          |          |  |        |             |
| 59. CALIBRATION    | Y                    | I           | 60. D            | ATA REC  | ov           | ERY         |        | 61.      | FREC     | DUENCY OF C                            | BSERV  | ATION       |
|                    |                      |             | 1                |          |              |             |        |          |          | INUOU                                  |        |             |
| 62. TELEMETRY      | REQUIREMENTS         |             | 1                |          |              |             |        | 100      | .z : ¥ ¶ | 1,100,0                                |        |             |
|                    |                      |             |                  |          |              |             | ***    |          |          |  |        |             |
|                    |                      |             |                  |          |              |             |        |          |          |  |        |             |
|                    |                      |             |                  |          |              |             |        |          |          |  |        |             |
| 63. ADVANTAGE      | S AND LIMITATIO      | NS          |                  |          |              |             |        |          |          |  |        |             |
|                    |                      |             |                  |          |              |             |        |          |          |  |        |             |
|                    |                      |             |                  |          |              |             |        |          |          |  |        |             |
| 64. REFERENCES     |                      |             |                  | 1        |              |             | •      |          |          |  |        |             |
| PRELIMINAL         | RY DATA SHE          | EET F       | OR N             | IMBUS    | 5 <b>-</b> F | F, NOV      | /••    | 1970.    | •        |  |        |             |
|                    |                      |             |                  |          |              |             |        |          |          |  |        |             |
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| 65. HISTORICAL     | REMARKS              |             |                  |          |              |             |        |          |          |  |        |             |
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#### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION **GODDARD SPACE FLIGHT CENTER** GREENBELT, MD. 20771

| 1. TITLE             |                   |        |                    |         |                   |       | 2. A               | CRONYM    | 3. E  | XP NO           |  |
|----------------------|-------------------|--------|--------------------|---------|-------------------|-------|--------------------|-----------|-------|-----------------|--|
| ELECTRICA            | LLY-SCANN INC     | MIC    | ROWAVE RADI        | OMET    | ER                |       | ES                 | MR        | E 1 2 | 2               |  |
| (TITLE CONT.)        |                   |        |                    |         |                   |       | 4 RE               | SUME DATE | 5     | ERSION          |  |
|                      |                   |        |                    |         |                   |       | 09                 | /01/7     | 2     | 2009            |  |
| 6. PRINCIPAL IN      | IVESTIGATOR       | 7. OR  | GANIZATION         |         |                   | 8. TI | ELEPHO             | NE        |       |                 |  |
| NORDBERG .           | DR. W.            | GODE   | DARD SPACE FI      | LT C    | ENTER             | 301   | 1-982              | 982-5042  |       |                 |  |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION         |         |                   | 11. T | ELEPHO             | NE        |       |                 |  |
|                      |                   |        |                    |         |                   |       |                    |           |       |                 |  |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER ·   | 14. FLASH INDEX NU | MBER    | 15. START<br>DATE | 16. C | OMPLETION<br>DATE  | 17. STAT  | rus   |                 |  |
|                      |                   |        |                    |         | <b>1</b> 1/69     |       |                    | ENG.MODEL |       |                 |  |
| 18. MONITOR          |                   | 19. AG | ENCY               | 20. PGN | OFFICE            | 21. 1 | relepho            | NE        |       |                 |  |
| SCHARDT,             | B.B.              | NASA   | HDQTRS             | OA/     | ERN               | 202   | 2 <b>-7</b> 55     | -2322     | >     |                 |  |
| 22. VENDOR           |                   |        | 23. LOCATION       |         |                   |       | 24. FLIGHT<br>DATE | 25. L     | EAD   | TIME            |  |
| SPACE GEN            | IERAL CORP        |        | EL MONTE, C        | ALIF    | ORNIA             |       | 12/7               | 2 30      | MON   | NTHS            |  |
| 26. INSTRUMEN        | T TYPE            |        |                    |         |                   |       |                    |           |       | 27.<br>SECURITY |  |
| RADIOMETE            | R, 19.35-GHZ      | ELE    | CTRONICALLY        | -SCA    | NNING             | MIC   | CROWA              | VE        |       | UNC             |  |
| 28. APPLICATIO       | N .               |        |                    | 2       | 29. SPACE         | CRAF  | Т                  |           |       |                 |  |
| MET, GEOF            | P, OCEAN          |        |                    |         |                   |       |                    |           |       |                 |  |
| 30. PURPOSE          |                   |        |                    |         |                   |       |                    |           |       |                 |  |

PRIMARY- TO MAP GLOBALLY AND CONTINUOUSLY THE THERMAL RADIATION EMITTED BY THE EARTH'S SURFACE AND ATMOSPHERE AT A FREQUENCY OF 19.35 GHZ.\*\*\* SECONDARY - TO DEMONSTRATE THE FEASIBILITY OF DEPLOYED PHASED-ARRAY ANTENNAS.

#### 31. PRINCIPLES OF OPERATION

THE RADIOMETER WILL BE USED TO MEASURE PRECISELY THE INTENSITY OF 19.35 GHZ THERMAL RADIATION. THE VIEWING DIRECTION OF THE ANTENNA IS ELECTRONICALLY SCANNED PLUS AND MINUS 50 DEGREES FROM THE NADIR NORMAL TO THE SPACECRAFT GROUND TRACK, PRODUCING A BRIGHTNESS TEMPERATURE MAP OF THE SURFACE OF THE EARTH AND ITS ATMOSPHERE UNDER THE SPACECRAFT. THIS SCANNING CONSISTS OF 78 DISCRETE VIEW POSITIONS AND IS CONTROLLED BY AN INTERNAL COMPU-TER. ANGULAR SEPARATION OF VIEW POSITIONS ALLOWS AN 8.5 PERCENT OVERLAP. THE ANTENNA THERMAL TEMPERATURE MUST BE MEASURED. CALIBRATION IS ACHIEVED WITH TWO REFERENCE SOURCES, ONE AT 338 DEGREES KELVIN. THE OTHER NEAR 50 DEGREES KELVIN (A SPACE-VIEWING HORN). THE 90 BY 90 CENTIMETER ANTENNA IS DEPLOYED AFTER ORBIT IS ACHIEVED. THE ANGULAR RESOLUTION OF THE ANTENNA WILL BE 1.4 DEGREES AT THE 3 DB POINTS AT THE BROADSIDE SETTING AND 1.5 DEGREES AT THE MAXIMUM SCAN POSITIONS OF PLUS AND MINUS 50 DEGREES.

#### 32. PHENOMENA OBSERVED

HORIZONTALLY POLARIZED TELLURIC THERMAL EMISSIONS AT 19.35 GHZ

33. MEASUREMENT RANGE

DYNAMIC TEMPERATURE RANGE = 50 TO 330 DEGREES K

34. PRECISION AND ACCURACY

RMS TEMPERATURE WITHIN 1.0 DEG K; ABSOLUTE TEMP.WITHIN 2.0 DEG K

| 35. SPECTRAL RANGE   | 36. SPECTRAL RESOLUTION 37. TIME CONSTANT  |
|--|--|
| 19.35  | GHZ 3.10 PERCENT   |
| L  | 39. GROUND SWATH   |
|  | 1400 NM BY 13 NM FROM 600 NM ALTITUDE  |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESC  |  |
|  | M 600 NM ORBIT   |
| 42. POINTING ACCURACY 43. POINTING RATE  | <u> </u>   |
|  | MED SUN-SYNCH HIGH NOON  |
| 46. SPECIAL REQUIREMENTS   |  |
| 47 COMPONENTS  |  |
| 47. COMPONENTS   | TENNA, CALIBRATION TEMPERATURE SOURCES   |
| 48. WEIGHT 49. VOLUME  | 50. AVERAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF  |
| 55 LB 4.5 CU F1  | the state of the s |
| 54. INTERFERENCE 55. INTERFERENCE 56. INTE   | IUCLEAR ST. THERMAL SERVER SE. SHIELDING   |
| SENSITIVE SENSITIVE NON  |  |
| 59. CALIBRATION  | 60. DATA RECOVERY 61. FREQUENCY OF OBSERVATION   |
| TWO REFERENCE SOURCES  | DELAYED TELEMETRY. CONTINUOUS  |
| 62. TELEMETRY REQUIREMENTS   |  |
| 10 BIT WORD READ EACH 2  | 25 MILLISECONDS. SERIAL READOUT.   |
|  |  |
|  |  |
| 63. ADVANTAGES AND LIMITATIONS   |  |
| III  | SSION TO EXCEED 95 PERCENT, ANTENNA DESIGN   |
| AND DEPLOYMENT MOST CRI  | ITICAL.  |
| 64. REFERENCES   | CAL FOR MARRING FARTH RADIATION AND CLOUD  |
| · ·  | SAL FOR MAPPING EARTH RADIATION AND CLOUD  |
|  | TRICALLY SCANNING MICROWAVE RADIOMETER.  |
| The state of the s | L: PRELIMINARY RESULTS FROM AIRCRAFT CTRICALLY SCANNING MICROWAVE RADIOMETER,  |
|  | 67.***3) TOBIN, M.: SUPPORT DATA FOR   |
| I · · · · · · · · · · · · · · · · · · ·  | 2, NASA X-622-67-450, SEP 67.  |
| 65. HISTORICAL REMARKS   |  |
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# NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771

| 1. TITLE             |                 |        |                   |         |                   |                  | 2. ACF             | MYNO        | 3. EXP NO       |
|----------------------|-----------------|--------|-------------------|---------|-------------------|------------------|--------------------|-------------|-----------------|
| LLECTRON             | ICALLY SCAN     | NING   | MICROWAVE RA      | DIOM    | ETER              |                  | ESM                | R-F         |                 |
| (TITLE CONT.         | .)              |        |                   |         |                   |                  | 4. RESU            | ME DATE     | 5.<br>VERSION   |
|                      |                 | _      |                   |         |                   |                  | 097                | 01772       |                 |
| 6. PRINCIPAL II      | NVESTIGATOR     | 7. OR  | GANIZATION        |         |                   | 8. T             | ELEPHONE           |             |                 |
| NORDBERG             | , W.            | GODI   | DARD SPACE F      | LIGH    | T CEN             | 301              | -982-              | 5C42        | <del> </del>    |
| 9. CO-INVESTIG       | ATOR            | 1      | GANIZATION        |         | ****              | 11. T            | ELEPHONE           | =           |                 |
| CONAWAY,             | A. W.           | GOD!   | DARD SPACE F      | LIGH    | T CEN             | 301              | -982-              | 5042        |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NU | MBER   | 14. FLASH INDEX N | UMBER   | 15. START<br>DATE | 16. <sup>C</sup> | OMPLETION 17       | STATU       | S               |
| ·                    |                 |        |                   |         |                   |                  | Р                  | ROPOS       | SAL             |
| 18. MONITOR          |                 | 19. AG | ENCY              | 20. PGN | OFFICE            | 21. T            | ELEPHON            | E           |                 |
| SCHARDT,             | €.8.            | NASA   | A HDQTRS          | OAZ     | ERN               | 202              | 2-755-             | 2322        |                 |
| 22. VENDOR           |                 |        | 23. LOCATION      |         |                   |                  | 24. FLIGHT<br>DATE | 25. LE      | AD TIME         |
|                      |                 |        |                   |         | -                 |                  | 1974               |             |                 |
| 26. INSTRUMEN        | IT TYPE         |        |                   |         |                   |                  |                    | <del></del> | 27.<br>SECURITY |
| RADIOMETE            | ER, MICROWA     | V E    |                   |         |                   |                  |                    |             | UNC             |
| 28. APPLICATIO       | N               |        |                   | 2       | 9. SPACE          | CRAF             | T                  |             |                 |
| MET, ERSI            | P               |        |                   | 1       | NIMBUS            | S-F              |                    |             |                 |

#### 30. PURPOSE

PRIMARY-TO MEASURE LIQUID WATER CONTENT OF CLOUDS\*\*\*SECONDARY-TO MEASURE DISTRIBUTION AND VARIATION OF SEA-ICE COVER\*\*\*TERTIARY-TO MEASURE GROSS CHARACTERISTICS OF LAND-SURFACES(VEGETATION, SOIL MOISTURE, AND SNOW COVER).

#### 31. PRINCIPLES OF OPERATION

THE INSTRUMENT IS A CICKE TYPE RADIOMETER CONSISTING OF A SINGLE TIME-SHARED RECEIVER AND AN ELECTRICALLY SCANNING PHASED ARRAY ANTENNA OPERATING AT C.S-CM. THE ANTENNA BEAM IS SCANNED THROUGH +OR-35 DEG THROUGH 98 DISCRETE BEAM POSITIONS. ANGULAR RESOLUTION WILL BE APPROXIMATELY 0.75 DEG AT THE 3 DB PUINTS AT BROADS IDF SETTING. THE BEAM TILT ANGLE IS 40 DEG FROM THE ARRAY NORMAL. THE BRIGHTNESS TEMPERATURE MEASURED BY THIS INSTRUMENT DEPENDS PRIMARILY UPON THE LIQUID WATER CONTENT OF CLOUDS WHEN MEASURED AT LOW-AND MID-LATITUDES. AT POLAR LATI-TUDES, THE MEASURED BRIGHTNESS TEMPERATURE IS PRIMARILY RELATED TO THE OCCUPRENCE OF SEA ICE AND SNOW COVER ON THE ICE. OVER LAND, THE MEASURED BRIGHTNESS TEMPERATURES WILL DEPEND LARGELY ON THE COMPOSITION, ROUGHNESS, AND TEMPERATURE OF THE SURFACE. MEASUREMENTS AT BOTH POLARIZATIONS WILL PERMIT THE DELINEATION OF THESE PARAMETERS, ESPECIALLY BETWEEN SURFACE POUGHNESS AND MOISTURE. THE ABSOLUTE VALUE OF THE RADIATION TEMPERATURE OF THE ANTENNA WILL BE MEASURED TO AN ACCURACY OF 2 DEG K. BRATION WILL BE ACHIEVED BY THE USE OF THREE REFERENCE SOURCES, 180, 300, AND 338 DEG K.

#### 32. PHENOMENA OBSERVED

MICROWAVE EMISSION FROM EARTH AND CLOUDS

#### 33. MEASUREMENT RANGE

37 GHZ IN VERTICAL AND HORIZONTAL POLARIZATION

#### 34. PRECISION AND ACCURACY

SEE ITEM 31

| 35. SPECTRAL          | RAN         | GE                       |          |                           |           | 36                  | . SPECT  | RAL RE                                 | SOL      | UTION       | 37. TIME    | CONSTANT                              |
|-----------------------|-------------|--------------------------|----------|---------------------------|-----------|---------------------|----------|--|----------|-------------|-------------|---------------------------------------|
| 37                    | 7. ii       |                          | GH       | 12                        |           |                     |          |  |          |             | <del></del> | ****                                  |
| 38. FIELD OF V        | IEW         | ±                        |          | 39. GRC                   | UND       | SWATH               |          |  |          | T           |             |                                       |
| 0.75                  |             |                          |          |                           |           | 3Y 84               | MN O     | FRO!                                   | 4 6      | OO NA       | 1 ORBI      | T                                     |
| 40. ANGULAR RES       |             |                          | L RESC   | DLUTION                   | J         |                     |          |  | *******  |             |             |                                       |
|                       |             | G 8 NM                   |          |                           |           |                     | _        |  | ,        |             |             |                                       |
| 42. POINTING ACCU     | JRAC        | 43. POINTING             | RATE     | <u> </u>                  | 44.       | ALTITU              | DE       | ···                                    | 45.      | INCLINA     | TION        | <u> </u>                              |
|                       |             |                          |          |                           | <u>L</u>  |                     |          |  |          | <del></del> |             |                                       |
| 46. SPECIAL RE        | QUI         | REMENTS                  | *        |                           |           |                     | <u></u>  |  |          |             |             |                                       |
|                       |             | A                        | 10000    | men fram again a sequipor | - Transit | T August 11 Table 1 |          |  |          |             |             |                                       |
| 47. COMPONEN          |             | CEIVER,                  | <u> </u> | TOOM                      | 7.00      | -                   |          |  |          |             |             |                                       |
| ANTENNA<br>48. WEIGHT |             | VOLUME                   | CLEC     |                           |           | E POWER             | E1 CTA   | NDBY PO                                | web T    | 52 DEA      | K POWER     | 53. MTBF                              |
| 80 LB                 | Secure com- | 5.1 CU                   | FT       |                           |           | ATTS                |          | NDST FO                                |          | JZ. FLA     | KI OIIEII   | 33. M 1 6 F                           |
| 54. INTERFERENCE      |             | MAGNETIC<br>INTERFERENCE |          | UCLEAR<br>RFERENCE        |           | 57. THERM           |          | 58.5                                   | SHIF     | LDING       |             | <u> </u>                              |
| INTERFERENCE          | ╁           | INTERFERENCE             | INTE     | RFERENCE                  |           | INTERPE             | RENUE    | 1 30.                                  | J1 11 L. | LO1140      |             |                                       |
| 59. CALIBRATIO        | ON          |                          | 1        | 60. [                     | DATA      | RECOV               | ERY      |  |          | 61. FRE     | DUENCY OF C | BSERVATION                            |
| ON BOARD              |             |                          |          |                           |           |                     |          | ······································ |          |             | INUOU       |                                       |
| 62. TELEMETR          | Y RE        | QUIREMENTS               |          |                           |           |                     |          |  |          |             |             |                                       |
|                       |             |                          | V        |                           |           |                     | <u> </u> | .,                                     | ·····    | ~·          |             |                                       |
|                       |             |                          |          |                           |           |                     |          |  |          |             |             |                                       |
| 63 ADVANTAG           | FS (        | ND LIMITATIO             | NC       | z                         |           | <del></del>         |          |  |          |             | ·           |                                       |
| OS. ADVANIAC          |             | CHO EMITTATIO            |          |                           |           |                     |          |  |          |             |             | ***                                   |
| 1                     |             |                          |          |                           |           |                     |          |  |          |             |             |                                       |
| 64. REFERENCI         | ES          |                          |          |                           |           |                     |          | <del></del>                            |          |             |             |                                       |
| PRELIMINA             |             |                          | FFT      | FOR                       | NIM       | BUS-                | F • 09   | CT.                                    | 19       | 70          |             | · · · · · · · · · · · · · · · · · · · |
|                       |             | סאוא סוו                 |          | , , , ,                   | • • •     |                     | , , ,    |  | •        |             |             |                                       |
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|                       |             |                          |          |                           |           |                     |          |  |          |             |             |                                       |
| 65. HISTORICA         | L RE        | MARKS                    |          |                           |           |                     | 1        |  |          |             |             |                                       |
| ····                  |             |                          |          | _                         |           |                     |          |  |          |             |             |                                       |
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| L                     |             |                          |          |                           |           |                     |          |  |          |             |             |                                       |

### INSTRUMENT RESUME NATIONAL AERONAUTICS AND SPACE ADMINISTRATION **GODDARD SPACE FLIGHT CENTER**

POPPHOPIT MD 20771

|                      |                   | ,      | GREENBELI, NID. 2  | 20// 1  |                   |                  |                   |            |     |                 |  |
|----------------------|-------------------|--------|--------------------|---------|-------------------|------------------|-------------------|------------|-----|-----------------|--|
| 1. TITLE             |                   |        |                    |         |                   |                  | 2                 | ACRONYM    | A   | EXP NO          |  |
| EREP MUL             | TISPECTRAL SO     | CANN   | ER                 |         |                   |                  | EM                | SS         | S-  | 192             |  |
| (TITLE CONT.         |                   |        |                    |         |                   |                  | 4.6               | ESUME DATE |     | 5.<br>VERSION   |  |
|                      |                   | -      |                    |         |                   |                  | 0.5               | 9/01/      | 72  | 2004            |  |
| 6. PRINCIPAL IN      | NVESTIGATOR       |        | GANIZATION         |         |                   | 8. TI            | ELEPHO            | NE         |     |                 |  |
| KORB, C.             | L.                | MANI   | NED SPACECRAF      | FT C    | ENTER             | 71               | 3-48              | 3-012      | 3   |                 |  |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION         |         |                   | 11. T            | ELEPHO            | LEPHONE    |     |                 |  |
|                      |                   |        |                    |         |                   |                  |                   |            |     |                 |  |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | MBER    | 15. START<br>DATE | 16. <sup>C</sup> | OMPLETION<br>DATE |            |     |                 |  |
|                      |                   |        |                    |         |                   |                  |                   | ENG .      | 400 | EL              |  |
| 18. MONITOR          |                   | 19. AG | ENCY               | 20. PGA | M OFFICE          |                  | <b>TELEPH</b>     |            |     |                 |  |
| FISCHETT             | I, T.L.           | NAS    | HDQTRS             | DA /    | ERS               | 202              | 2-75              | 5-232      | 2   |                 |  |
| 22. VENDOR           |                   |        | 23. LOCATION       |         |                   |                  | 24. FLIGH<br>DATE | ¹ 25. L    | EAC | TIME            |  |
| HONEYWELI            | RADIATION (       | EN.    |                    |         |                   |                  | 19                | 73         |     |                 |  |
| 26. INSTRUMEN        | IT TYPE           |        |                    |         |                   |                  |                   |            |     | 27.<br>SECURITY |  |
| CONICAL S            | SCANNING RADI     | COME   | rer                |         |                   |                  |                   |            |     | UNC             |  |
| 28. APPLICATIO       | N .               |        |                    |         | 29. SPACE         |                  | Т                 |            |     |                 |  |
| ERSP                 |                   |        |                    |         | SKYLAI            | B-A              |                   |            |     |                 |  |
| 30. PURPOSE          |                   |        |                    |         |                   |                  |                   |            |     |                 |  |
|                      |                   |        |                    |         |                   |                  | :                 |            | _   |                 |  |

TO GATHER HIGH RESOLUTION LINE SCAN IMAGERY OF SELECTED EARTH RESOURCES GROUND CALIBRATION SITES IN SIMULTANEOUS SPECTRAL BANDS COMPARABLE TO ERTS A & ERAP DATA. OBJECTIVE IS FEASIBILITY EVALUATION OF SPECTRUM MATCHING DATA PROCESSING TECHNIQUES FOR IDENTIFICATION OF EARTH RESOURCES FEATURES.

#### 31. PRINCIPLES OF OPERATION

THE INSTRUMENT CONSISTS OF AN OPTICAL-MECHANICAL SCANNER, A SPECTRAL DISPERSION SYSTEM. A GROUP OF THREE IN-FLIGHT CALIBRA-TION SOURCES, AND AN ARRAY OF DETECTORS (SI, GE, HG-CD-TE). OUTPUT OF THE DETECTORS IS AMPLIFIED, DIGITIZED, REFORMATTED AND RECORDED ON TAPE. A FOLDED 12-INCH REFLECTING TELESCOPE IS THE THE USE OF THIS LARGE COLLECTOR WILL PROVIDE THE NECESSARY DIFFRACTION-LIMITED RESOLUTION FOR THE THERMAL IR CHANNEL (10.2-12.5 MICRONS) AS WELL AS PROVIDING THE NECESSARY ENERGY THROUGHOUT TO ACHIEVE MODERATE S/N RATIOS IN A HIGH RE-SOLUTION SYSTEM. THE RADIANT ENERGY COLLECTED BY THE SCAN MIRROR IS CONSTRAINED TO PASS THROUGH TWO NEARLY ADJACENT EN-TRANCE SLITS WHICH ARE SIZED FOR EQUIVALENT ANGULAR FOV\*S. THE SLITS ACT AS BOTH THE FIELD STOP OF THE TELESCOPE AND THE ENTRANCE SLIT FOR THE PRISM SPECTROMETER. SINCE THE PADIANT ENERGY PASSES THROUGH THE FIELD STOPS PRIOR TO SPECTRAL SEPARA-TION, EACH DETECTOR ON A GIVEN SCAN LINE OBSERVES THE SAME SPA-TIAL ELEMENT ON THE GROUND, BUT IN A DIFFERENT SPECTRAL REGION. THE THIRTEEN SPECTRAL BANDS ARE 0.41-0.46, 0.46-0.51, 0.52-0.556 AND 0.565-0.609, 0.62-0.67, 0.68-0.762, 0.783-0.88, 0.98-1.08, .09-1.19, 1.20-1.30, 1.55-1.75, 2.10-2.35 AND 10.2-12.5 MICRONS

#### 32. PHENOMENA OBSERVED

REFLECTED AND THERMAL RADIATION FROM THE EARTH'S SURFACE

#### 33. MEASUREMENT RANGE

VISIBLE, NEAR IR, AND THERMAL WAVELENGTHS

#### 34. PRECISION AND ACCURACY

ABOUT 1% IN VISIBLE & REFLECTIVE IR, 0.4 DEG K IN THERMAL IR

| 35. SPECTRAL RANGE   | 20 00507041 05001 151011 03 5111             |
|--|--|
|  | 36. SPECTRAL RESOLUTION 37. TIME CONSTANT    |
|  | SEE ITEM 31                                  |
|  |  |
| 0.02 BY 10. DEG 40 NM  40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION | FROM ORBIT                                   |
| 0.005 DEG 130 FT VISIBLE, 260  | FT IR FROM ORBIT                             |
| 42. POINTING ACCURACY 43. POINTING RATE 44. ALT                      |  |
| 235  | NM 50 D EG                                   |
| 46. SPECIAL REQUIREMENTS   | 100  |
| CRYO-COOLER & DETECTORS REPLACEA                                     | BLE BY OPERATOR.                             |
| 47. COMPONENTS   |  |
| OPTICAL-MECHANICAL SCANNER, PRIS                                     | M SPECTROMETER, DICHROIC FILTER              |
| 48. WEIGHT 49. VOLUME 50. AVERAGE POW                                | ER 51. STANDBY POWER 52. PEAK POWER 53. MTBF |
|  | TS 90 WATTS 266 WATTS                        |
| 54. INTERFERENCE 55. MAGNETIC 56. INTERFERENCE 57. INT               | HERMAL SHIELDING                             |
|  | NSITIVE                                      |
| 59. CALIBRATION 60. DATA REC   |  |
|  | TAPE RETURN   FLEXIBLE                       |
| 62. TELEMETRY REQUIREMENTS   | O DIT ACCUDACY                               |
| ONBOARD RECORD 22 DATA CHANNELS,                                     | 8-BIT ACCURACY.                              |
| 1.0 MBITS/SEC/TRACK.   |  |
| 63. ADVANTAGES AND LIMITATIONS                                       |  |
| PERMITS COMPARISONS OF SPECTRAL                                      | TMACERY IN COMPATIBLE ENRMAT                 |
| WITH ERTS-A, EREP, & GROUND SITE                                     | •  |
| 64. REFERENCES   | 111101111111111111111111111111111111111      |
| EXPERIMENT IMPLEMENTATION PLAN F                                     | OR MANNED SPACE ELIGHT EXPERI-               |
| MENTS, TITLE: TEN-BAND MULTISPEC                                     |  |
|  |  |
| SKYLAB A, EREP USERS HANDBOOK, N                                     |  |
| SKYLAB A, EREP USERS HANDBOOK, N                                     |  |
| SKYLAB A, EREP USERS HANDBOOK, N                                     |  |
|  |  |
| SKYLAB A, EREP USERS HANDBOOK, N  65. HISTORICAL REMARKS             |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
| 65. HISTORICAL REMARKS   | ASA MSC, FEB. 1971.                          |
| 65. HISTORICAL REMARKS   | ASA MSC, FEB. 1971.                          |
| 65. HISTORICAL REMARKS   | ASA MSC, FEB. 1971.                          |
| 65. HISTORICAL REMARKS   | ASA MSC, FEB. 1971.                          |
| 65. HISTORICAL REMARKS   | ASA MSC, FEB. 1971.                          |
| 65. HISTORICAL REMARKS   | ASA MSC, FEB. 1971.                          |
| 65. HISTORICAL REMARKS   | ASA MSC, FEB. 1971.                          |
| 65. HISTORICAL REMARKS   | ASA MSC, FEB. 1971.                          |
| 65. HISTORICAL REMARKS   | ASA MSC, FEB. 1971.                          |
| 65. HISTORICAL REMARKS   | ASA MSC, FEB. 1971.                          |
| 65. HISTORICAL REMARKS   | ASA MSC, FEB. 1971.                          |
| 65. HISTORICAL REMARKS   | ASA MSC, FEB. 1971.                          |

# INSTRUMENT RESUME NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER

|                      |                 |        | GREENBELT, MD   | . 20// 1 |                   |                 |              |     |               |
|----------------------|-----------------|--------|-----------------|----------|-------------------|-----------------|--------------|-----|---------------|
| 1. TITLE             | ·               |        |                 |          |                   |                 | 2. ACRONY    | м 3 | . EXP NO      |
| FLAT-PL              | ATE RADIOME     | TER    |                 |          |                   |                 | FPR          |     |               |
| (TITLE CON           | IT.)            |        |                 | <u>-</u> |                   |                 | 4. RESUME DA | TE  | 5.<br>VERSION |
|                      |                 |        |                 |          |                   |                 | 09/01        | 772 | 2 0009        |
| 6. PRINCIPAL         | INVESTIGATOR    | 7. OR  | GANIZATION      |          |                   | 8. TELE         | PHONE        |     |               |
| PARENT,              | DR. R.J.        | UNI    | VERSITY OF      | WISCO    | NSIN              | 608-            | 262-07       | 24  |               |
| 9. CO-INVEST         | IGATOR          | 10. OR | GANIZATION      |          |                   | 11. TELE        | EPHONE       |     |               |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NU | JMBER  | 14. FLASH INDEX | NUMBER   | 15. START<br>DATE | 16. COMPL<br>DA | ETION 17. ST | ATU | s -           |
|                      |                 |        |                 |          |                   |                 | INT          | EGF | RATION        |
| 18. MONITOR          |                 | 19. AG | ENCY            | 20. PGM  | OFFICE            | 21. TEL         | EPHONE       |     |               |
| GARBACZ              | , M.L.          | NAS    | A HDQTRS        | OA/      | ERO               | 202-            | 755-23       | 22  |               |

22. VENDOR 23. LOCATION 24. FLIGHT 25. LEAD TIME UNIVERSITY OF WISCONSIN MADISON, WISCONSIN 1/70 NA
26. INSTRUMENT TYPE

ECURITY

UNC

RADIOMETER, FOUR IR/VISIBLE LOW RESOLUTION THERMISTORS.

28. APPLICATION 29. SPACECRAFT

MET ITOS-1

#### 30. PURPOSE

PRIMARY-TO GATHER DATA TO AID IN DETERMINING: (1)THE GEOGRAPHIC DISTRIBUTION OF ENERGY RADIATED FROM THE EARTH AND THE RELATION-SHIP OF THIS ENERGY TO INCOMING ENERGY FROM THE SUN AND (2) THE REFLECTION AND SCATTERING OF SOLAR RADIATION BY THE EARTH-ATMOSPHERE SYSTEM.

#### 31. PRINCIPLES OF OPERATION

THE ITOS FLAT PLATE RADIOMETER (FPR), WILL ALSO BE FLOWN ON ITOS A, B, AND C. THE PRINCIPAL PART OF EACH RADIOMETER IS A THIN ALUMINUM DISK, THE TEMPERATURE OF WHICH IS SENSED BY THERMISTORS MOUNTED ON THE BACK SURFACE. THE HOUSING TEMPERATURES ARE SEPARATELY SENSED AND RECORDED. THERE ARE 2 PAIRS OF SENSORS. ONE DISK OF EACH PAIR IS PAINTED BLACK AND ONE IS ANODIZED ALUMINUM. THE BLACK PAINTED SURFACE WILL RESPOND TO THE SUM OF THE REFLECTED SOLAR, DIRECT SOLAR, AND RERADIATED LONG-WAVE RA-DIATION. THE ANODIZED ALUMINUM (WHITE) DISKS REFLECT IN THE VISIBLE RANGE BUT ARE BLACK TO IR BEYOND 7 MICRONS. THESE ABSORB THE RERADIATED ENERGY FROM THE EARTH AND EXCLUDE TO A HIGH DEGREE THE DIRECT AND REFLECTED SOLAR RADIATION. BLACK/WHITE PAIR WILL OPERATE AS RADIATIVE EQUILIBRIUM DETEC-TORS, SIMILAR TO ESSA. THE 2ND PAIR IS OF A NEW THERMAL FEED-BACK DESIGN. THE ENERGY REQUIRED TO MAINTAIN A CONSTANT TEMPER-ATURE WILL BE MEASURED. THE SET OF 4 RADIOMETERS ARE MOUNTED BETWEEN THE 2 SCANNING RADIOMETERS AND POINT TO THE NADIR. THE FIELD OF VIEW IS 180 DEGREES FOR ALL FOUR SENSORS.

#### 32. PHENOMENA OBSERVED

ENERGY RADIATED FROM AND REFLECTED BY THE EARTH-ATMOSPHERE

#### 33. MEASUREMENT RANGE

NEAR UV VISIBLE, NEAR IR, THERMAL IR.

#### 34. PRECISION AND ACCURACY

5K DEGREES IN THERMAL IR.

1

| 35. SPECTRAL     | RANGE   |                    |       |              |          |              |              |            | 36.      | SPEC    | TRA         | L RE  | SOLI        | JTION       | 37. TIN  |              |    |       | <u> </u>                                |
|------------------|---------|--------------------|-------|--------------|----------|--------------|--------------|------------|----------|---------|-------------|-------|-------------|-------------|----------|--------------|----|-------|---|
| 0.3              |         |                    | 3     | 0.0          |          | M ]          | CR           | ON         | <u> </u> |         |             |       |             |             | CON      | TIN          | UC | US    |   |
| 38. FIELD OF V   | IEW     |                    | 44.11 |              | 39       | 9. GR        | OUNI         | D SW       | ATH      |         |             |       |             |             |          |              |    |       |   |
|                  |         | 1                  | 80.   | DEC          | 3 L      | IME          | 3 <b>- T</b> | 0-L        | IMI      | 3 (     | 370         | ו מי  | (MV         | FRO         | M 50     | ON           | М  | ALT   | •                                       |
| 40. ANGULAR RES  | OLUTION | 41.                | SPATI | AL RE        | SOL      | UTIO         | N            |            |          |         |             |       |             |             |          |              |    |       |   |
|                  |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |
| 42. POINTING ACC | JRACY   | 43. PC             | INTIN | IG RA        | TE       |              | 44           | . ALT      | ITUI     | DE      |             |       | 45.1        | NCLINA      | TION     |              |    |       |   |
|                  | -+      |                    |       |              |          |              | М            | €D         | С        | IRC     | ULA         | R     | SU          | N SY        | VCH      | RE           | TR | OGR   | ADE                                     |
| 46. SPECIAL RE   | QUIRE   | MEN                | rs    |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |
|                  |         |                    |       |              |          | _            |              |            |          |         |             |       |             |             |          |              | -  |       |   |
| 47. COMPONEN     | TS      |                    |       |              |          |              |              |            |          |         |             | -     |             |             |          | -            |    |       |   |
| 4 SENSOR         |         | HER                | MIS   | TORS         |          | FI           | FC           | TRO        | MIC      | ~ c     |             |       |             |             |          |              |    |       |   |
| 48. WEIGHT       | 49. VC  |                    |       | 1 U N C      |          | 50. AV       |              |            |          | 51. S   | CANDE       | Y POV | VED T       | 52. PEA     | K POWE   | R            | 53 | MTBF  |   |
| 7                | 45. VC  |                    | 75    |              | $\dashv$ | 30. AV       | ENAG         |            | ren      | 31.3    |             |       |             | -           |          | -            |    |       |   |
|                  | 1 = 1   | MAGNETI<br>TERFERE |       | 1 50         | NUCL     | FAR          |              | Ter        | THERM    | AL .    | —т          | E0 6  | <u> </u>    | DINC        |          |              |    | 1 T   | EAR                                     |
| 54. INTERFERENCE | 55. INT | ERFERE             | NCE   |              |          | EAR<br>RENCE |              |            |          |         | <del></del> |       |             | DING        | 4 1 1 14 |              |    |       |   |
|                  |         |                    |       | 126          | - N S    | _            |              |            |          |         | Vt.         | + P)  | <u> </u>    | HERM        |          |              |    |       |   |
| 59. CALIBRATI    |         |                    |       |              |          |              |              | A RE       |          |         |             |       |             | <del></del> | QUENCY   |              |    | VALIO | IN .                                    |
| VIEW OF          |         |                    |       |              |          | TDE          | :LA`         | Y ED       | T_       | LE      | MET         | RY    |             | TCON.       | TINU     | <u> 200</u>  |    | ,     |   |
| 62. TELEMETR     |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |
| 15 WORDS         | CON     | STI                | TUT   | E ON         | E        | FPR          | F            | RAM        | E (      | )F      | DAT         | Δ,    | 8           | BITS        | TO T     | THE          | W  | ORD   | •                                       |
| THE FRAM         | E IS    | RE                 | AD (  | TUC          | SE       | RIA          | LL           | Y A        | T :      | 15      | BPS         | T.    | 1 X         | NG 8        | SEC      | ONC          | s. | DA    | TA                                      |
| SAMPLING         |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |
| 63. ADVANTAC     |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |
| INSTRUME         | NT T    | S R                | ROA   | D R A        | NG       | F.           | LO           | W A        | וחס      | JRΔ     | CY          | TY    | ) F _       |             |          |              |    |       |   |
| 1                |         | - 0                |       |              |          | ₩ ₩          | (            | ., ~       |          |         | <b>.</b> .  |       | \- <b>•</b> |             |          |              |    |       |   |
| 64. REFERENC     | ES      |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       | *************************************** |
| 1) DESIGN        |         | nv                 | DED   | ) D T        | ΕO       | D T          | HE           | T AA       | DD r     | ) \ / C | T T         | 05    | / T T       | OS)         | VCT      | - M          | 11 | 1     | 2                                       |
|                  |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    | -     |   |
| RCA ASTR         |         |                    |       |              |          |              |              |            |          |         |             |       |             | •           |          |              |    |       |   |
| 2) RUBIN,        |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       | -                                       |
| DATA FROM        | M ES    | 5 A                | SAII  | LLI          | 1 6      | 2.           | t: 53        | SA         | 16(      | .H      | KEP         | UR 1  | ı N         | E 50-4      | +2, F    | - <b>t</b> B | •  | 196   | 8.                                      |
|                  |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |
|                  |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |
| 65. HISTORICA    |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          | _            |    |       |   |
| THIS FPR         | 15      | SIM                | ILAF  | <u>₹ Т.:</u> | T        | <u>H0 S</u>  | E f          | <u>FLO</u> | WN       | DN      | E S         | SA    | 3,          | 5.          | 7 . AN   | 1D           | 9. |       |   |
|                  |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |
|                  |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |
|                  |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |
|                  |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       | ,                                       |
|                  |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |
|                  |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |
|                  |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |
|                  |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |
|                  |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       | Ì                                       |
|                  |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |
|                  |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       | Ċ                                       |
|                  |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |
|                  |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |
| 1                |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       | Ì                                       |
|                  |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |
|                  |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |
| 1                |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |
|                  |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |
| 1                |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |
|                  |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |
|                  |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |
|                  |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |
|                  |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |
| 1                |         |                    |       |              |          |              |              |            |          |         |             |       |             |             |          |              |    |       |   |

# INSTRUMENT RESUME NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771

| 1. TITLE             |                   |        |                 |     |         |                   |       | 2. /              | ACRONYN   | 3.  | EXP NO          |
|----------------------|-------------------|--------|-----------------|-----|---------|-------------------|-------|-------------------|-----------|-----|-----------------|
| FLAT-PLA             | TE RADIOMETE      | P.     |                 |     |         |                   |       | FF                | R         |     |                 |
| (TITLE CONT          | .)                |        |                 |     |         |                   |       | 4 R               | ESUME DAT | E   | 5.<br>VERSION   |
|                      |                   |        |                 |     |         |                   |       | 00                | 7/01/     | 72  | 2008            |
| 6. PRINCIPAL I       | NVESTIGATOR       | 7. OR  | GANIZATION      |     |         |                   | 8. T  | ELEPHO            | NE        |     |                 |
| PARENT,              | DR. R.J.          | UNI    | VERSITY OF      | WI  | SCON    | NS IN             | 60    | 8-262             | 2-072     | 4   |                 |
| 9. CO-INVESTIO       |                   | 10. OR | GANIZATION      |     |         |                   | 11. T | ELEPHO            | NE        |     |                 |
|                      |                   |        |                 |     |         |                   |       |                   |           |     |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUME | BER    | 14. FLASH INDEX | NU  | MBER    | 15. START<br>DATE | 16.   | OMPLETION<br>DATE | 17. STA   | TUS |                 |
| CPFF                 |                   |        |                 |     |         |                   |       |                   | OPER      | AΤ  | IONAL           |
| 18. MONITOR          |                   | 19. AG | ENCY            |     | 20. PGM | OFFICE            | 21.   | TELEPHO           | ONE       |     |                 |
| GARBACZ,             | M.L.              | NAS    | A HDQTPS        |     | OA/E    | ĒŔŊ               | 20    | 2-755             | -232      | 2   |                 |
| 22. VENDOR           |                   |        | 23. LOCATION    | _   |         |                   |       | 24 FLIGHT<br>DATE | 25.       | LEA | D TIME          |
| UNIVERSI             | TY OF WISCON      | SIN    | MADISON,        | WIS | CON!    | SIN               |       | 12/7              | AN O      |     |                 |
| 26. INSTRUMEN        | NT TYPE           |        |                 |     |         |                   |       |                   |           |     | 27.<br>SECURITY |
| RADIOMET             | ER, IR/VISIB      | LE LO  | DW-RESOLUT      | ION | THE     | ERMIST            | ΓER   | BOLO              | METE      | R   | UNC             |
| 28. APPLICATIO       |                   |        |                 |     |         | 9. SPACE          |       |                   |           |     |                 |
| MET                  |                   |        |                 |     |         | NOAA-             | -1    |                   |           |     |                 |
| 30. PURPOSE          |                   |        |                 |     |         |                   |       |                   |           |     |                 |

PRIMARY-TO GATHER DATA TO AID IN DETERMINING: (1)THE GEOGRAPHIC DISTRIBUTION OF ENERGY RADIATED FROM THE EARTH AND THE RELATION-SHIP OF THIS ENERGY TO INCOMING ENERGY FROM THE SUN AND (2) THE REFLECTION AND SCATTERING OF SOLAR RADIATION BY THE EARTH-ATMOSPHERE SYSTEM.

#### 31. PRINCIPLES OF OPERATION

AN IDENTICAL FLAT PLATE RADIOMETER (FPR), WILL ALSO BE FLOWN UN ITOS B AND C AND HAS FLOWN ON ITOS-1. THE PRINCIPAL PART OF EACH RADIOMETER IS A THIN ALUMINUM DISK, THE TEMPERATURE OF WHICH IS SENSED BY THERMISTORS MOUNTED ON THE BACK SURFACE. HOUSING TEMPERATURES ARE SEPARATELY SENSED AND RECORDED. THERE ARE 2 PAIRS OF SENSORS. ONE DISK OF EACH PAIR IS PAINTED BLACK AND ONE IS ANODIZED ALUMINUM. THE BLACK PAINTED SURFACE WILL RESPOND TO THE SUM OF THE REFLECTED SOLAR. DIRECT SOLAR. AND RE-RADIATED LONG-WAVE RADIATION. THE ANODIZED ALUMINUM (WHITE) DISKS REFLECT IN THE VISIBLE RANGE BUT ARE BLACK TO IR BEYOND 7 THESE ABSORB THE RERADIATED ENERGY FROM THE EARTH MICRONS. AND EXCLUDE TO A HIGH DEGREE THE DIRECT AND REFLECTED SOLAR RADIATION. ONE BLACK/WHITE PAIR WILL OPERATE AS PADIATIVE EQUILIBRIUM DETECTORS, SIMILAR TO ESSA. THE 2ND PAIR IS OF A NEW THERMAL FEEDBACK DESIGN. THE ENERGY REQUIRED TO MAINTAIN A CONSTANT TEMPERATURE WILL BE MEASURED. THE SET OF 4 RADIOMETERS ARE MOUNTED BETWEEN THE 2 SCANNING RADIOMETERS AND POINT TO THE NADIR. THE FIELD OF VIEW IS 180 DEGREES FOR ALL FOUR SENSORS.

#### 32. PHENOMENA OBSERVED

EARTH ALBEDO-ENERGY RADIATED TO SPACE BY FARTH
33. MEASUREMENT RANGE

NEAR UV. VISIBLE, NEAR IR, THERMAL IR

34. PRECISION AND ACCURACY

5 K DEG IN THERMAL IP

| 35. SPECTRAL      | PANCE  |                       |         | -                     | - T        | 36 SPF           | CTRAL RE   | SOLL     | ITION      | 37. TIME      | CONSTANT    |            |
|-------------------|--|-----------------------|---------|-----------------------|------------|------------------|------------|----------|------------|---------------|-------------|------------|
| 0.3               |  |                       | 30.0    | M 1                   | CRONS      | <del></del>      | OTHAL NE   |          | 71.0.1     |               | ONT INUOL   | īs         |
| 38. FIELD OF V    | <u> </u>   |                       |         | <del></del>           | OUND SWA   | ГН               |            |          |            |               |             |            |
| 180               | DEG  | <u> </u>              |         | LI                    | MB-TO-     | LIM              | 3          |          |            |               |             |            |
| 40. ANGULAR RESC  | DLUTION  | 41. SPAT              | IAL RES | SOLUTION              | N .        |                  |            |          |            |               |             | 1          |
| NA                |  |                       |         |                       |            |                  |            |          |            |               |             |            |
| 42. POINTING ACCL | JRACY 4  | 43. POINTI            | NG RAT  | ΓE                    | 44. ALTI   | TUDE             |            | 45. 1    | NCLINA     | TION          |             | į          |
|                   |  |                       |         |                       | MED        | CIR              | CULAR      | SU       | N-SY       | NCH R         | ETROGRAD    | DE         |
| 46. SPECIAL RE    | QUIRE  | MENTS                 |         |                       |            |                  |            |          |            |               |             | _          |
| NONE              |  |                       |         |                       |            |                  |            |          |            |               |             | _          |
| 47. COMPONEN      |  |                       |         |                       |            |                  |            |          |            |               | <del></del> | <u>.</u> ! |
| 4 SENSOR          | <del>-                                    </del> |                       | STURS   | <del></del>           |            |                  |            |          | 50 DE A    | Y DOWED       | LEO MATRE   | _          |
| 48. WEIGHT        | 49. VO   |                       | CII S   |                       | ERAGE POWE | R 51.            | STANDBY PO | VER      | 52. PEA    | KPOWER        | 53. MTBF    |            |
| 7 LB              |  | 0.75                  |         |                       | En TH      | ERMAL<br>FERENCE | 150 6      |          | DING       |               | 1 1 1 1 1 1 | <u></u>    |
| 54. INTERFERENCE  | 35. INT  | MAGNETIC<br>ERFERENCE |         | NUCLEAR<br>TERFERENCE |            |                  |            |          | DING       | ALLY I        | SOLATED     | ⊣          |
| 59. CALIBRATION   | ON   |                       | 131     |                       | DATA REC   |                  |            |          |            |               | OBSERVATION | ⊣          |
| VIEW OF           |  | ING                   |         |                       | LAYED      |                  |            |          | CON        | TINUOL        | IS          |            |
| 62. TELEMETR      |  |                       | s       |                       |            | · 1 C.           |            |          | 1 3 .5.4   | , _ , , , , , |             | $\neg$     |
| 15 WORDS          |  |                       | -       | VE FPR                | FRAME      | OF               | DATA.      | 8        | BITS       | TO TH         | E WORD.     |            |
| THE FRAM          |  |                       |         |                       |            |                  |            |          |            |               |             |            |
| 8 SEC.            |  |                       |         |                       |            |                  |            |          |            |               |             |            |
| 63. ADVANTAG      | SES AN   | D LIMITAT             | TIONS   |                       |            |                  |            |          |            |               |             |            |
| INSTRUME          | NT I   | S BRO                 | AD RA   | ANGE,                 | LOW AC     | CUR              | ACY TY     | PE.      |            |               |             |            |
| 64. REFERENC      | ES   |                       |         |                       |            | -                |            | _        |            |               |             |            |
| 1)DESIGN          | STU  | DY REI                | PORT    | FOR T                 | HE IMP     | ROV              | ED TOS     | (IT      | 08)        | SYSTEM        | , V.1.2.    | ,          |
| RCA ASTR          | O-EL   | ECTRO                 | VICS .  | CONT                  | RACT N     | 10.              | VAS5-9     | 034      | , JU       | NE 7,         | 1968.***    | *          |
| 2)RUBIN,          |  |                       |         |                       |            |                  |            |          |            |               |             |            |
| DATA FRO          | M ES   | SA SA                 | [ELL]   | ITES.                 | ESSA 1     | ECH              | REPOR      | ΤN       | ESC-       | 42, FE        | B. 1968.    | •          |
|                   |  |                       |         |                       |            |                  |            |          |            |               |             |            |
| CE LUCTORIOA      |  | 10/0                  |         |                       |            |                  |            |          |            |               |             |            |
| 65. HISTORICA     |  |                       | AD TO   | THOS                  | E CLO      | (N O             | U ECCA     | -        | <b>6</b> 7 | O AND         | I TO C- 1   | $\dashv$   |
| THIS FPR          | 12   | 21MIL                 | AK IL   | <u> </u>              | E FLUM     | IN U             | A E22A     | <u> </u> | 3919       | 9 ANU         | 1102-1      | ⊣          |
| ļ                 |  |                       |         |                       |            |                  |            |          |            |               |             | 1          |
|                   |  |                       |         |                       |            |                  |            |          |            |               |             |            |
|                   |  |                       |         |                       |            |                  |            |          |            |               |             |            |
|                   |  |                       |         |                       |            |                  |            |          |            |               |             |            |
|                   |  |                       |         |                       |            |                  |            |          |            |               |             |            |
|                   |  |                       |         |                       |            |                  |            |          |            |               |             |            |
|                   |  |                       |         |                       |            |                  |            |          |            |               |             |            |
| ,                 |  |                       |         |                       |            |                  |            |          |            |               |             |            |
|                   |  |                       |         |                       |            |                  |            |          |            |               |             |            |
|                   |  |                       |         |                       |            |                  |            |          |            |               |             | ļ          |
|                   |  |                       |         |                       |            |                  |            |          |            |               | •           |            |
|                   |  |                       |         |                       |            |                  |            |          |            |               |             |            |
|                   |  |                       |         |                       |            |                  |            |          |            |               |             |            |
|                   |  |                       |         |                       |            |                  |            |          |            |               |             |            |
|                   |  |                       |         |                       |            |                  |            |          |            |               |             |            |
|                   |  |                       |         |                       |            |                  |            |          |            |               |             |            |
|                   |  |                       |         |                       |            |                  |            |          |            |               |             | -          |
|                   |  |                       |         |                       |            |                  |            |          |            |               |             |            |
|                   |  |                       |         |                       |            |                  |            |          |            |               |             |            |

|   | NATIONAL          | GODE     | ONAUTICS AND SPA   | T CEN   |                   | RATION     |                    |               |
|---|-------------------|----------|--------------------|---------|-------------------|------------|--------------------|---------------|
|   |                   |          | GREENBELT, MD. 2   | 20//1   |                   |            |                    | 2 5 10 10     |
| 1. TITLE                                | OLUTION INFRA     | ADEN     | PARTOMETER         |         |                   |            | 2. ACRONYM<br>HRIR | 3. EXP NO     |
| <del></del>                             |                   | AN ED    | NAUTOMETER         |         |                   |            |                    | 15.           |
| (TITLE CONT.                            | )                 |          |                    |         |                   |            | 4, RESUME DATE     | 5.<br>VERSION |
| 0.0000000000000000000000000000000000000 | W (FOTIOA TOR     | 7 00     | GANIZATION         |         |                   | 8. TELEI   |                    | 2 3003        |
| FOSHEE .                                |                   |          | DARD SPACE FL      | T ()    | NITER             | 8. IELEI   | HONE               | •             |
|   | <del> </del>      |          |                    |         | -1411-1           | 11 TELE    | DUONE              |               |
| 9. CO-INVESTIG                          | ATOR              | 10. OR   | GANIZATION         |         |                   | 11. TELE   | PHONE              |               |
| 12. CONTRACT<br>TYPE                    | 13. CONTRACT NUMB | EP       | 14. FLASH INDEX NU | MOED    | 15. START<br>DATE | 16. COMPLE | TION 17. STAT      | 118           |
| TYPE                                    | 13. CONTRACT NOME | EN       | 14. FLASH INDEX NU | MIDER   | DATE              | DAT        |                    | FLIGHT        |
| 18. MONITOR                             | 1                 | 19. AG   | ENCV               | 20. PGM | OFFICE            | 21. TELE   | <del>-</del>       | LIGHT         |
|   | М.                |          | A HDOTES           | DA/E    |                   |            | 755-2322           | )             |
| 22. VENDOR                              | 1.                | INAS     | 23. LOCATION       | CAT     | . 117             |            |                    | EAD TIME      |
|   | STRIAL LABS       |          | FORT WAYNE,        | IND     | ΤΛΝΙΛ             |            | 3/64               | CAD TIME      |
| 26. INSTRUMEN                           |                   |          | TON HATREY         | 1110    | ANA               |            | 707                | 27.           |
|   | ER . SINGLE-CI    | IANN     | EL SCANNING 1      | NER     | ARED              |            |                    | UNC           |
| 28. APPLICATIO                          |                   | (A) TIVE | LE SCAMILIO        |         | 9. SPACEO         | PAET       |                    | 10140         |
| MET                                     | · N               |          |                    |         | VIMBUS            |            |                    |               |
| 30. PURPOSE                             |                   |          |                    |         | 111100            |            |                    |               |
|   | TO MAP THE EA     | ARTH     | S CLOUD COVE       | · R Λ   | T NIGH            | IT. TH     | ILS COMP           | DIF-          |
| L .                                     | THE TV COVER      |          |                    |         |                   |            |                    |               |
|   | DARY - TO MEAS    |          |                    |         |                   |            |                    |               |
| *                                       | TERRAIN FEAT      |          |                    |         | _                 | . 101.2    | 0, 000             | ,,,           |
| TOFS PIND                               | I CHIMIN I CM     | UNE.     | •                  |         |                   |            |                    |               |
|   |                   |          |                    |         |                   |            |                    |               |
| 31. PRINCIPLES                          | OF OPERATION      |          |                    |         |                   |            | ·                  |               |
|   | LE-CHANNEL SO     | ΔΝΝ      | ING HRIR WAS       | FLOS    | NO N              | NIMBI      | IS 1 AND           | 2.            |
|   | VERSIONS ARI      |          |                    |         |                   |            |                    | D.            |
|   | JS 1 HRIR COI     |          |                    |         |                   |            |                    |               |
| i                                       | L WHICH IS RA     |          |                    |         |                   |            |                    |               |
|   | THE 3.4 TO 4      |          |                    |         |                   |            |                    |               |
|   | A BLACK COOL      |          |                    |         |                   |            |                    |               |
| i _                                     | D-COATED HORI     | -        | THE RADIOMET       |         |                   |            |                    |               |
|   | .5 DEG. WHICH     |          |                    |         |                   |            |                    |               |
|   | ON OF 5 NM.       |          |                    |         |                   |            |                    |               |
|   | OF ROTATION       |          |                    |         |                   |            |                    |               |
|   | ETECTOR THROU     |          |                    |         |                   |            |                    |               |
|   | LOCITY. THE       |          |                    |         |                   |            |                    |               |
| RULVEL                                  | PROVIDE ZERI      | J VVII   | A OI THE HUU.      | CALTI   | AINU S<br>Danti   | DE BOT     | UNITO 1            | 4<br>[UE      |
|   | N REFLECTED       |          |                    |         |                   |            |                    |               |
|   | OCUS OF A 4       |          |                    |         |                   |            |                    |               |
|   | EN REFOCUSED      |          |                    |         |                   |            |                    |               |
|   | MICRON WAVEL      |          |                    |         |                   |            |                    |               |
|   |                   |          |                    |         |                   |            |                    |               |
| 44.7 RPM                                | . THE OUTPUT      | T SI     | GNAL HAS AN        | INFO    | RMATIC            | IN BAI     | HTGIWON            | OF            |

#### 32. PHENOMENA OBSERVED

COMMAND.

EMITTED SURFACE RADIATION FROM 3.4 TO 4.2 MICRONS

#### 33. MEASUREMENT RANGE

RADIANCE TEMPERATURE BETWEEN 210 AND 330 DEG K

### 34. PRECISION AND ACCURACY

NOISE EQUIV TEMP DIFF OF 1 K DEG FOR A 250-DEG K BACKGROUND

280 HZ. THE INFORMATION IS STORED ON TAPE FOR PLAYBACK ON

| 35. SPECTRAL RANGE                                 | 36. SPECTRAL RESOLUTI  | ON 37. TIME CONSTANT       |
|--|--|----------------------------|
|  | RONS   |                            |
|  | ND SWATH   |                            |
|  | NM BY 5 NM FROM 600  | NM ALTITUDE                |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION      |  |                            |
| 0.5 DEG 5 NM FROM 600 N                            | ······································   |                            |
|  |  | LINATION                   |
|  | MED CIRCULAR SUN-  | SYNCH RETROGRADE           |
| 46. SPECIAL REQUIREMENTS                           | 8  |                            |
| 47. COMPONENTS                                     | The second secon |                            |
| RADIOMETER, RECORDER, ELECTR                       | ONITCS   |                            |
|  | AGE POWER 51. STANDBY POWER 52.  | PEAK POWER 53. MTBF        |
| 7 7 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1            | the state of the s | 12 WATTS                   |
| 54. INTERFERENCE 55. INTERFERENCE 56. INTERFERENCE | 57. THERMAL SHIELDI  |                            |
| SENSITIVE INTERPERENCE                             | SENSITIVE  | 10                         |
|  | <del>, , , , , , , , , , , , , , , , , , , </del>  | . FREQUENCY OF OBSERVATION |
| 2 MEAS EACH 360 DEG SCAN DEL                       |  | IGHTSIDE OF ORBIT          |
| 62. TELEMETRY REQUIREMENTS                         |  |                            |
| THE SIGNAL IS RECTIFIED, RES                       | ULTING IN A DC DUTP  | UT VARYING                 |
| FROM 0 TO -6 VOLTS AND HAVING                      |  | · ·                        |
|  |  |                            |
| 63. ADVANTAGES AND LIMITATIONS                     |  |                            |
| USEFUL DATA DURING NIGHTTIME                       | RE INTERFERENCE D  | EGRADED SOME               |
| SCANS, MOVING PARTS.                               |  |                            |
| 64. REFERENCES                                     |  |                            |
| 1) NIMBUS HIGH RESOLUTION RAD                      |  |                            |
| V.1. GSFC, JAN. 65***2)SIG A                       | CHIEV IN SPACE APPL  | ICATIONS 1966.             |
| NASA SP-156, 1967. *** 3GOLDBE                     | RG, I.L.:METEOROLOG  | ICAL IR INSTRU-            |
| MENTS FOR SATELLITES.PRESENTI                      | ED AT 13TH ANNUAL T  | ECH SYMP OF SOC            |
| OF PHOTO-OPTICAL ENGR, AUG 2:                      | 3, 1967.***4)HRIR D  | ATA AVAILABLE              |
| FROM: NIMBUS DATA, CODE 650,                       | NASA SPACE SCIENCE   | DATA CTR, GSFC.            |
| 65. HISTORICAL REMARKS                             |  | 1                          |
| ALSO FLOWN ON NIMBUS 2, 3. MC                      | DDIFIED VERSION WIL  | L FLY ON NIMBUS D          |
|  |  |                            |
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# INSTRUMENT RESUME NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771

|                      |                   |        |                    | _       |                   |       |                   |             |      |                 |
|----------------------|-------------------|--------|--------------------|---------|-------------------|-------|-------------------|-------------|------|-----------------|
| 1. TITLE             |                   |        |                    |         |                   |       | 2.                | ACRONYM     | 3.   | EXP NO          |
| HIGH-RESC            | LUTION INFRA      | RED    | RADIOMETER         |         |                   |       | HF                | RIR         |      |                 |
| (TITLE CONT.         | )                 |        | <u> </u>           |         |                   |       | 4. 6              | RESUME DATE |      | 5.<br>VERSION   |
|                      |                   |        |                    |         |                   |       | 0.5               | 9/01/       | 72   | 0004            |
| 6. PRINCIPAL II      | VVESTIGATOR       | 7. OR  | GANIZATION         |         |                   | 8. TI | ELEPHO            | NE          |      |                 |
| FOSHEE, L            | L.                | GODE   | DARD SPACE FL      | T CI    | ENTER             |       |                   |             |      |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION         |         |                   | 11. T | ELEPHO            | ONE         |      |                 |
|                      |                   |        |                    |         |                   |       |                   |             |      |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | MBER    | 15. START<br>DATE | 16. C | OMPLETION<br>DATE | 17. STA     | TUS  |                 |
|                      |                   |        |                    |         | l                 |       |                   | POST        | FL   | IGHT            |
| 18. MONITOR          | -                 | 19. AG | ENCY               | 20. PGN | OFFICE            | 21. T | ELEPH             | ONE         |      |                 |
| HALEY, DE            | ₹. Ŕ.             | NASA   | A HDQTRS           | OA/     | ERN               | 202   | 2 <b>-7</b> 59    | 5-2327      | 2    | _               |
| 22. VENDOR           |                   |        | 23. LOCATION       |         |                   |       | 24. FLIGH<br>DATE | T 25. I     | -EAC | TIME            |
| ITT INDUS            | TRIAL LABS        |        | FORT WAYNE,        | IND     | IANA              |       | 05/6              | 66          |      |                 |
| 26. INSTRUMEN        | T TYPE            |        |                    |         |                   |       |                   |             |      | 27.<br>SECURITY |
| RADIOMETE            | R, SINGLE-CH      | IANNE  | L SCANNING I       | NER     | ARED              |       |                   |             |      | UNC             |
| 28. APPLICATIO       | N                 |        |                    | [2      | 29. SPACE         | CRAF  | T                 |             |      |                 |
| MET                  |                   |        |                    |         | NIMBUS            | S 2   |                   |             |      |                 |
| 30 PHRPOSE           |                   |        |                    |         |                   |       |                   |             |      |                 |

PRIMARY- TO MAP THE EARTH'S CLOUD COVER AT NIGHT TO COMPLEMENT THE TV COVERAGE DURING THE DAYTIME PORTION OF THE ORBIT.\*\*\*
SECONDARY-TO MEASURE THE TEMPERATURES OF CLOUD TOPS AND TERRAIN

FEATURES.

#### 31. PRINCIPLES OF OPERATION

THE SINGLE CHANN'EL SCANNING HRIR WAS FLOWN IN NIMBUS 1 AND 2. MODIFIED VERSIONS ARE SCHEDULED FOR FLIGHT ON NIMBUS B AND D. THE NIMBUS 2 HRIR CONTAINED A LEAD SELENIDE (PBSE) PHOTOCONDUC-TIVE CELL WHICH IS RADIATION COOLED TO -75 DEGREES C AND OPER-ATES IN THE 3.4 TO 4.2 MICRON REGION. COOLING IS ACCOMPLISHED BY MEANS OF A BLACK COOLING PATCH AT THE BOTTOM OF A HIGHLY RE-FLECTIVE GOLD-COATED HORN. THE RADIOMETER HAS AN INSTANTANEOUS FOV OF 1/2 DEG. WHICH AT AN ALTITUDE OF 600 NM GIVES A GROUND RESOLUTION OF 5 NM. THE SCAN MIRROR IS INCLINED 45 DEGREES TO THE AXIS OF ROTATION AND CONTINUOUSLY ROTATES THE FIELD OF VIEW OF THE DETECTOR THROUGH 360 DEG IN A PLANE NORMAL TO THE SPACE-CRAFT VELOCITY. THE VIEW OF THE HOUSING AND SPACE DURING A RO-TATION PROVIDE ZERO AND WARM BODY CALIBRATION POINTS. RADIATION REFLECTED FROM THE SCAN MIRROR IS CHOPPED AT 1.5 KHZ AT THE FOCUS OF A 4 INCH F/1 MODIFIED CASSEGRAINIAN TELESCOPE. IT IS THEN REFOCUSED AT THE DETECTOR BY RELAY MIRRORS WITH THE 3.4-4.2 MICRON WAVELENGTH FILTER BETWEEN THEM. THE SCAN RATE IS 44.7 RPM. THE OUTPUT SIGNAL HAS AN INFORMATION BANDWIDTH OF 280 HZ. THE INFORMATION IS STORED ON TAPE FOR PLAYBACK ON COM-MAND OR IS TRANSMITTED DIRECTLY TO APT STATIONS.

32. PHENOMENA OBSERVED

EMITTED SURFACE RADIATION FROM 3.4 TO 4.2 MICRONS

33. MEASUREMENT RANGE

RADIANT TEMPERATURE BETWEEN 210 AND 330 DEGREES KELVIN

34. PRECISION AND ACCURACY

NOISE EQUIVALENT TEMP DIFF OF 1 DEG K FOR A 250 DEG K BACKGROUND

| 35. SPECTRAL F             | RANG  |                       |             |          |                    |              | 36                 | 6. SP | ECT    | RAL RE                                 | SOLU     | ITION       | 37. 1  | IME ( | CONST    | ANT        |
|----------------------------|-------|-----------------------|-------------|----------|--------------------|--------------|--------------------|-------|--------|--|----------|-------------|--------|-------|----------|------------|
| 3.4                        | 1     | 0                     | 4           | • 2      | M                  | CRO          | VS.                |       |        |  |          |             |        |       |          |            |
| 38. FIELD OF V             | EW    |                       |             |          |                    | OUND         |                    |       |        |  |          |             |        |       |          |            |
|                            | 3 Y   |                       |             |          | 1300               |              | BY                 | 5     | NM     | FRO                                    | 4 6      | <u>00 N</u> | M AI   | TI    | TUDE     |            |
| 40. ANGULAR RESC           |       | <del></del>           |             |          |                    |              |                    |       |        |  |          | <u> </u>    |        |       |          |            |
| 0.5                        |       |                       |             |          | 600                |              |                    |       |        |  | 1        | 101 101     | . 7101 |       |          |            |
| 42. POINTING ACCU          | RACY  | 43. PO                | INTINC      | RATE     | <u> </u>           |              | ALTITU             |       |        | 40                                     | <u> </u> | NCLIN.      |        |       | TOC      | GRADE      |
| 46. SPECIAL RE             | QUIR  | EMENT                 | s           |          |                    | MEI          | <u> </u>           | 1K    | CUL    | AK                                     | 1 201    | V-SY        | NUH    |       | CINC     | IGRAUE     |
| 47. COMPONEN               | TS    | <del></del> .         | <del></del> |          |                    | <del></del>  | ·                  |       | -,     |  |          |             |        |       |          |            |
| RADIOMETE                  | R,    | REC                   | ORDE        | R, F     | L EC 1             | RON          | ICS_               |       |        |  |          |             |        |       |          |            |
|                            | 49. V | OLUME                 | <u> </u>    | _        | 50. A\             | /ERAGE       |                    |       | . STAN | DBY PO                                 | WER      | 52. PE/     |        |       | 53. M    | ITBF       |
| 12 LB                      | _     |                       |             |          |                    |              | ATTS               |       |        |  |          | 12          | MA.    | TTS   | <u> </u> | ··, »      |
| 54. INTERFERENCE           | _     | MAGNETIC<br>ITERFEREN | CE          | 56. INTE | UCLEAR<br>RFERENCE |              | 7. THER<br>INTERFE |       |        |  |          | DING        |        |       |          |            |
| SENSITIVE                  |       |                       |             | <u> </u> |                    |              |                    |       |        | RF                                     | SH       |             |        |       |          | COOL       |
| 59. CALIBRATIO             |       |                       |             |          |                    | DATA         |                    |       |        |  |          |             |        |       | BSERV    |            |
| 2 MEAS EA                  |       |                       |             | SCA      | NIDE               | LAY          | ED A               | ND    | R      | ALT                                    | IME      | NIG         | H15.   | IDE   | UF       | OKRII      |
| 62. TELEMETRY              |       |                       |             |          | - +                |              | ~                  |       |        |  |          | 0117        | DUT    | 14.4  | 2474     | 10         |
| THE AC SI                  |       |                       |             |          | -                  | -            |                    |       |        |  |          |             |        |       |          | i6 ·       |
| 63. ADVANTAG               |       |                       |             |          |                    |              |                    |       |        | —————————————————————————————————————— |          |             |        |       |          |            |
| IMPROVED                   |       |                       |             |          |                    |              |                    |       |        |  | ON       | DAT         | A WI   | HEN   | APT      | WAS        |
| OPERATING<br>64. REFERENCE |       | JSEFL                 | JL D        | ATA      | ONLY               | <u>, DUI</u> | RING               | N     | IG     | IT.                                    |          | - /*-       |        |       |          |            |
| 1) NIMBUS                  | 5 2   | USEF                  | 2 • 5       | GUI      | DE. C              | SSFC         | , JŪ               | LY    | 19     | 66.                                    | ***      | 2) \$1      | G A    | CHI   | EV I     | N          |
| SPACE APP                  | 19    | 966.                  | NAS         | A SF     | -156               | 5, 19        | 967.               | **    | *31    | GOL                                    | BER      | G, I        | .L.    | ME    | TEOR     | OLOGY      |
| INSTRUMEN                  | VTS   | FOR                   | SAT         | ELLI     | TES.               | PRI          | ESEN               | TE    | D A    | T 1                                    | 3TH      | ANN         | UAL    | TE    | CH S     | YMP        |
| OF SOC PE                  | HOTO  | )-OP1                 | ГІСА        | L EN     | IGR.               | , AU         | G 23               | ,     | 196    | 8.*                                    | **4      | 08          | SER    | VA T  | IONS     | FROM       |
| NIMBUS 1                   | MET   | r sai                 | r. N        | ASA      | SP-8               | 39,          | 1965               | . *   | **     | 5) H                                   | RIR      | DAT         | A A    | VAI   | LABL     | . <b>E</b> |
| FROM: NIN                  | 4BUS  | DA1                   | ΓΑ,         | CODE     | 650                | ) N/         | ASA                | SP    | ACE    | <u> </u>                               | IEN      | CE C        | TR,    | GSI   | FC.      |            |
| 65. HISTORICAL             |       |                       |             |          |                    |              |                    |       |        | ·                                      |          |             |        |       |          |            |
| ALSO FLOW                  | IN C  | ON N                  | <u>IMBU</u> | S 1      | <u>3.</u>          | MOD          | <u>IFIE</u>        | D     | VEF    | SIO                                    | N W      | ILL         | FLY    | ON    | NIM      | BUS D      |
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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771

| 1. TITLE             |                                       |        |                    |        |                   |             | 2. A               | CRONYM    | 3. E | XP NO           |
|----------------------|---------------------------------------|--------|--------------------|--------|-------------------|-------------|--------------------|-----------|------|-----------------|
| HIGH-RESC            | LUTION INFRA                          | RED    | RADIOMETER         |        |                   |             | HR                 | Ιb        | ]    |                 |
| (TITLE CONT.         | .)                                    |        |                    |        |                   |             | 4. RE              | SUME DATE | 5    | VERSION         |
|                      |                                       |        |                    |        |                   |             | 09                 | 70177     |      | 005             |
| 6. PRINCIPAL II      | NVESTIGATOR                           | 7. OR  | GANIZATION         |        |                   | 8. T        | ELEPHO             | NE        |      |                 |
| CHERRIX,             | G.T.                                  | GODE   | ARD SPACE FL       | TC     | ENTER             | 301         | -982               | -5042     | ·    |                 |
| 9. CO-INVESTIG       | ATOR                                  | 10. OR | GANIZATION         |        |                   | 11. T       | ELEPHO             | NE        |      |                 |
| ALLISON,             | L.J.                                  | GODE   | ARD SPACE FL       | TC     | ENTER             | 301         | 1-982              | -5042     | )    |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB                     | ER     | 14. FLASH INDEX NU | MBER   | 15. START<br>DATE | 16. 0       | OMPLETION DATE     | 17. STA   | TUS  |                 |
|                      |                                       |        |                    |        |                   |             | (                  | OPERA     | TIC  | NAL             |
| 18. MONITOR          |                                       | 19. AG | ENCY               | 20. PG | M OFFICE          | 21.         | TELEPHO            | NE        |      | _               |
| SCHARDT.             | B • B •                               | NASA   | HDQTRS             | DA/    | ERN               | 202         | 2-755              | -2322     | ,    |                 |
| 22. VENDOR           |                                       |        | 23. LOCATION       |        |                   |             | 24. FLIGHT<br>DATE | 25. L     | EAD  | TIME            |
| ITT INDUS            | TRIAL LABS                            |        | FORT WAYNE,        | IND    | IANA              |             | 04/6               |           |      |                 |
| 26. INSTRUMEN        | T TYPE                                |        |                    |        |                   | <del></del> |                    |           |      | 27.<br>SECURITY |
| RADIOMETE            | R, DUAL-CHAN                          | INEL   | INFRARED SCA       | NNI    | NG                |             |                    |           |      | UNC             |
| 28. APPLICATIO       | N .                                   |        |                    |        | 29. SPACE         | CRAF        | T                  |           |      | <u> </u>        |
| MET                  |                                       |        |                    |        | NIMBUS            | 3           |                    |           |      |                 |
| 30. PURPOSE          | · · · · · · · · · · · · · · · · · · · |        |                    |        |                   |             |                    |           |      |                 |
| 55 * 44 5 54 7       | 0 0004705 00                          |        | ALAT TAKE CL 0/40  |        | 555116            | 4 4 4 5     |                    | . = =     |      | ···             |

PRIMARY-TO PROVIDE BOTH DAYTIME CLOUD MAPPING AND NIGHTTIME RADIATION MEASUREMENTS ON A FULL TIME BASIS.\*\*\*SECONDARY- TO PROVIDE THIS INFORMATION TO APT STATIONS IN REALTIME ANYWHERE IN THE WORLD AS THE NIMBUS 3 PASSES OVERHEAD.

#### 31. PRINCIPLES OF OPERATION

A SINGLE-CHANNEL SCANNING HRIR WAS FLOWN ON NIMBUS 1 AND 2. MODIFIED VERSION IS SCHEDULED FOR NIMBUS 3. THE NIMBUS 3 HRIR WILL PROVIDE DATA IN 2 SPECTRAL REGIONS. NIGHTTIME DATA (3.4 TO 4.2 MICRONS) WILL PROVIDE CLOUD TOP OR SURFACE TEMPERATURES AS IN PREVIOUS HRIR'S. THROUGH THE USE OF A DUAL BAND-PASS FILTER. DAYTIME DATA (0.7 TO 1.3 MICRONS) WILL PRIMARILY PROVIDE MAPS OF CLOUD COVER BY MEASURING RELATIVE REFLECTED SOLAR RADIATION. THE HRIR SENSES RADIATION WITH A LEAD SELENIDE PHOTO-CONDUCTIVE CELL WHICH IS RADIATIVELY COOLED TO -75 DEG C. THE SCAN MIRROR IS INCLINED 45 DEG TO THE AXIS OF ROTATION AND CONTINUOUSLY ROTATES THE FOV OF THE DETECTOR THROUGH 360 DEG AT A RATE OF 48 RPM. IN A PLANE NORMAL TO THE SPACECRAFT VELOCITY. THE VIEW OF THE HOUSING AND SPACE DURING A ROTATION PROVIDE ZERO AND WARM BODY CALIBRATION POINTS. THE RADIATION REFLECTED FROM THE SCAN MIR-ROR IS CHOPPED AT 1.5 KHZ AT THE FOCUS OF A 4 INCH F/1 MODIFIED CASSEGRAINIAN TELESCOPE. IT IS THEN REFOCUSED AT THE DETECTOR BY RELAY MIRRORS WITH THE FILTER BETWEEN THEM. THE OUTPUT SIGNAL HAS AN INFORMATION BANDWIDTH OF 35C HZ. THIS INFORMATION IS STORED ON TAPE FOR PLAYBACK ON COMMAND OR CAN BE TRANSMITTED DIRECTLY TO APT GROUND STATIONS.

#### 32. PHENOMENA OBSERVED

EMITTED CLOUD-TOP AND SURFACE RADIATION DURING NIGHT AND DAY 33. MEASUREMENT RANGE

RADIANT TEMPERATURE BETWEEN 210 AND 330 DEG K.

34. PRECISION AND ACCURACY

CLOUD-TOP ALTITUDE TO 1000 FT; SURFACE TEMP TO APPROX 1 DEG

| 35. SPECTRAL RANGE                                     | 36. SPECTRAL RESOLUTION 37. TIME CONSTANT            |
|--|--|
|  |  |
|  | CRONS  |
|  | UND SWATH  |
|  | NM BY 5 NM FROM 600 NM ALTITUDE                      |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION          |  |
|  | FROM 600 NM ALTITUDE                                 |
| 42. POINTING ACCURACY 43. POINTING RATE                | 44. ALTITUDE 45. INCLINATION                         |
| 1.0 DEG  | MED CIRCULAR SUN-SYNCH RETROGRADE                    |
| 46. SPECIAL REQUIREMENTS                               |  |
|  |  |
| 47. COMPONENTS   |  |
| RADIOMETER, ELECTRONICS                                |  |
|  | RAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF |
|  | 9 WATTS  |
| 54. INTERFERENCE 55. MAGNETIC 56. NUCLEAR INTERFERENCE | 57. THERMAL SHIELDING                                |
|  | SENSITIVE   RADIATIVE COOLING                        |
| 59. CALIBRATION 60. D                                  | ATA RECOVERY 61. FREQUENCY OF OBSERVATION            |
| 2 MEAS EACH 360 DEG SCAN DEL                           | LAYED AND REALTIME CONTINUOUS                        |
| 62. TELEMETRY REQUIREMENTS                             |  |
| VIDEO INFORMATION BANDWIDTH                            | IS 350 HZ.   |
|  |  |
|  |  |
| 63. ADVANTAGES AND LIMITATIONS                         |  |
| THIS HRIR CAN PROVIDE USEFUL                           | L DAYTIME PICTURES WHERE PREVIOUS                    |
| ONES COULD NOT; MOVING PARTS                           |  |
| 64. REFERENCES   | <del></del>  |
| 11 GOLDBERG. T.L.: METEOROLI                           | DGY INSTRUMENTS FOR SATELLITES. PRE-                 |
| · ·  | SYMP OF SOC PHOTO-OPTICAL ENGRS. AUG                 |
|  | S KIT, NO. 68-84K, NASA MAY 10, 1968                 |
|  | GSFC, JULY 1966.***4) SABATINI,R.R.:                 |
|  | LAN. ALLIED RES ASSOC, TECH REPT NO.                 |
|  | LANA ALLIEU RES ASSUCA TECH REPT NU.                 |
| 4, MARCH, 1968.  |  |
|  | IN ON MEMBER 1 AND 2                                 |
| SINGLE-CHANNEL HRIR WAS FLOW                           | WN UN NIMBUS I AND Z.                                |
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# INSTRUMENT RESUME NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT MD 20771

|                      |                  |        | GREEN   | IBELT, MI | D. 2 | 07/1    |                   |                  |                    |            |     |                 |
|----------------------|------------------|--------|---------|-----------|------|---------|-------------------|------------------|--------------------|------------|-----|-----------------|
| 1. TITLE             |                  |        |         |           |      |         |                   |                  | 2. /               | ACRONYM    | 3.  | EXP NO          |
| HIGH RES             | DLUTION INF      | RARED  | RADI    | MOITA     | S    | JUNDE   | R                 |                  | HF                 | RIRS       |     |                 |
| (TITLE CONT.         | )                |        |         |           |      |         |                   |                  | 4 R                | ESUME DATE |     | 5.<br>VERSION   |
|                      |                  |        |         |           |      |         |                   |                  | 0.9                | 9/01/      | 72  | 2002            |
| 6. PRINCIPAL IN      | NVESTIGATOR      | 7. OR  | GANIZA  | TION      |      |         |                   | 8. T             | ELEPHO             | NE         |     |                 |
| MCCULLOCI            | H, A. W.         | GODI   | DARD    | SPACE     | Fl   | T C     | ENTER             | 30               | 1-982              | 2-504      | 2   |                 |
| 9. CO-INVESTIG       | ATOR             | 10. OR | GANIZA  | TION      |      |         |                   | 11. T            | ELEPHO             | NE         |     |                 |
| SMITH, W.            | . L.             | NOA    | Α       |           |      |         |                   |                  |                    |            |     |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUI | MBER   | 14. FL/ | ASH INDEX | NU   | MBER    | 15. START<br>DATE | 16. <sup>C</sup> | OMPLETION<br>DATE  | 17. STA    | rus |                 |
|                      |                  |        |         |           |      |         |                   | $\perp$          |                    | PROP       | os/ | ۱۲              |
| 18. MONITOR          |                  | 19. AG | ENCY    |           |      | 20. PGM | OFFICE            | 21. 1            | ELEPH              | ONE        |     |                 |
| SCHARDT,             | 8.8.             | NAS    | A HDO   | TRS       |      | DA/     | EŔN               | 20               | 2-755              | 5-232      | 2   |                 |
| 22. VENDOR           |                  |        | 23. LO  | CATION    |      |         |                   |                  | 24. FLIGHT<br>DATE | ' 25. L    | .EA | TIME            |
|                      |                  |        |         |           |      |         |                   |                  | 197                | 74         |     |                 |
| 26. INSTRUMEN        | T TYPE           |        |         |           |      |         |                   |                  |                    |            |     | 27.<br>SECURITY |
| RADIOMET             | ER, IR           |        |         |           |      |         |                   |                  |                    |            |     | UNC             |
| 28. APPLICATIO       | N                |        |         |           |      | 2       | 9. SPACE          | CRAF             | T                  |            |     |                 |
| MET                  |                  |        |         |           |      |         | NIMBU             | S-F              |                    |            |     |                 |
| 30. PURPOSE          |                  |        |         |           |      |         |                   |                  |                    |            |     |                 |
|                      |                  |        |         |           |      |         |                   |                  |                    |            | _   |                 |

PRIMARY-TO OBTAIN SIMULTANEOUS GLOBAL INFRARED RADIANCES IN THE 4.3 MICRON AND 15 MICRON GO2 BANDS TO DETERMINE THE THERMAL STRUCTURE OF THE ATMOSPHERE FROM THE GROUND TO 40 KM WITH THE HIGHEST ATMOSPHERIC TEMPERATURE RESOLUTION ACHIEVABLE WITH IR MEASUREMENTS.

#### 31. PRINCIPLES OF OPERATION

THE INSTRUMENT IS A FILTER WHEEL DEVICE WITH TWO WAVELENGTH RANGES SCANNING NORMAL TO THE ORBIT PLANE WITH A SCAN ANGLE OF +OP-35 DEG ABOUT THE NADIR. THE SHORT WAVELENGTH DETECTOR VIEWS THE 3.7 TO 4.6 MICRON PADIATION IN SIX INTERVALS. SIMUL-TANEGUSLY, THE LONG WAVELENGTH DETECTOR VIEWS FROM 6.3 TO 15 MI-CRONS IN TEN STEPS. AVERAGE CLEAR-COLUMN RADIANCES FOR EACH CHANNEL WILL BE DERIVED FROM A 10X10 MATRIX OF SPATIALLY INDE-PENDENT FOV'S. THE CLEAR COLUMN RADIANCE IS COMPUTED DIRECTLY FROM THE OBSERVED RADIANCES USING SURFACE TEMPERATURES AND EF-FFCTIVE OBSCURATION AMOUNT (THE PATIOS OF THE FRACTIONAL CLOUD COVERS OF ADJACENT FOV'S) ESTIMATED FROM 3.8 AND 11 MICRON WIN-DOW OBSERVATIONS. THE CLEAR-COLUMN RADIANCES IN THE 4.3 AND 15 MICRON CO2 CHANNELS WILL BE USED TO CALCULATE THE TEMPERATURE PROFILE FROM THE 40 KM LEVEL DOWN TO THE EARTH'S SURFACE. WATER VAPOR PROFILE OF THE TROPOSPHERE WILL BE DEDUCED FROM THE 6.3 MICRON WATER VAPOR ABSORPTION BAND MEASUREMENTS. THE SPA-TIAL RESOLUTION (15 NM) AND CONTIGUOUS GEOMETRIC SAMPLING WILL ALLOW CLEAR CLOUD INTERSTICES TO BE RESOLVED AND CONSEQUENTLY THE CLEAR AIR RADIANCE CONTRIBUTION TO BE EXTRACTED FROM THE OB-SERVED RADIANCES EVEN UNDER PARTIAL CLOUDY CONDITIONS.

#### 32. PHENOMENA OBSERVED

IR RADIANCES FROM THE ATMOSPHERE

33. MEASUREMENT RANGE

THERMAL IR REGION

34. PRECISION AND ACCURACY

| 35. SPECTRAL R     | ANGE  |                                       |         | 36. SPECTRA         | L RESOL   | UTION                                  | 37. TIME (  | CONSTANT    |
|--------------------|---|---------------------------------------|---------|---------------------|-----------|--|-------------|-------------|
| 3.8                | TO 15   | MI                                    | CRONS   |                     |           |  |             |             |
| 38. FIELD OF VII   | EW  | 39. GRO                               | UND SWA | TH                  |           |  |             |             |
| 1.5 B              | Y 1.5   | DEG 16 N                              | M BY    | 840 NM I            | FROM 6    | 00 N                                   | Ч           |             |
| 40. ANGULAR RESO   | LUTION 41. SPATIAL  | RESOLUTION                            |         |                     |           |  |             |             |
| 1.5                | DEG 16NM B  | Y 16NM F                              | ROM O   | RBIT                |           |  |             |             |
| 42. POINTING ACCUP | RACY 43. POINTING   | RATE                                  | 44. ALT |                     | 1         | INCLINA                                |             |             |
|                    |   |                                       | MED     | CIRCULA             | ₹ Su      | N-SY                                   | NCH RE      | TROGRADE    |
| 46. SPECIAL REC    | DUIREMENTS  |                                       |         | <u> </u>            |           |  |             |             |
|                    |   |                                       |         |                     |           | - Januari - I                          |             |             |
| 47. COMPONENT      |   |                                       |         | A = 0 0 1 1 A       |           | ann an Ama                             |             |             |
|                    | ECTECTOR,   |                                       |         |                     |           | 50 DE A                                | V DOWED     | 53. MTBF    |
| 48. WEIGHT 4       | 1 • 4   |                                       | 20 WA   | ER 51. STAND        | BYPOWER   | 52. FEA                                | Kronen      | 33. W F B F |
| S4. INTERFERENCE   | 55. MAGNETIC<br>INTERFERENCE  | 56. NUCLEAR                           |         | HERMAL<br>ERFERENCE | 58. SHIE  | DING                                   |             |             |
| INTERFERENCE       | INTERFERENCE  | INTERFERENCE                          | - INT   | ERFERENCE           | 06. SITTE | LDING                                  |             | ····        |
| 59. CALIBRATIO     | N   | 60. D                                 | ATA REC | OVERY               | <u> </u>  | 61. FRE                                | DUENCY OF C | BSERVATION  |
|                    |   |                                       | ELEME   |                     |           | CON                                    | TINUOU      | s           |
| 62. TELEMETRY      | REQUIREMENTS  | <u></u>                               |         | ·                   |           |  | <u> </u>    |             |
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|                    |   |                                       |         |                     |           |  |             |             |
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| 63. ADVANTAGE      | S AND LIMITATIO   | NS                                    |         |                     |           |  |             | Lucien      |
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| 64. REFERENCES     | 1000  |                                       |         |                     |           |  |             |             |
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| 65. HISTORICAL     | REMARKS   |                                       |         |                     | ·         | ······································ |             |             |
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# NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771

1. TITLE 2. ACRONYM 3. EXP NO INFRARED TEMPERATURE-PROFILE RADIOMETER ITPR (TITLE CONT.) 4. RESUME DATE VERSION 09/01/72 0009 6. PRINCIPAL INVESTIGATOR 7. ORGANIZATION 8. TELEPHONE SMITH, W.L. NOAA 301-899-1220 9. CO-INVESTIGATOR 10. ORGANIZATION 11. TELEPHONE WARK, D.Q. NOAA 301-899-1220 12. CONTRACT TYPE 16. COMPLETION 17. STATUS 13. CONTRACT NUMBER 14. FLASH INDEX NUMBER 15. START ENG.MODEL 18. MONITOR 19. AGENCY 20. PGM OFFICE 21. TELEPHONE SCHARDT. B.B. NASA HDOTES OA/ERN 202-755-2322 22. VENDOR 23. LOCATION 24. FLIGHT DATE 25. LEAD TIME GULTON INDUSTRIES ALBUQUERQUE, N.MEXICO 12/72 40 MONTHS 26. INSTRUMENT TYPE SECURITY RADIOMETER, 6-CHANNEL STEP-SCANNING INFRARED (MODIFIED MRIR) PRO 28. APPLICATION 29. SPACECRAFT MET NIMBUS E

30. PURPOSE

PRIMARY- TO TEST AN IR RADIOMETER WHICH IS DESIGNED TO MEET THE ENGINEERING AND SCIENTIFIC DEMANDS OF AN OPERATIONAL REMOTE TEMPERATURE SOUNDER\*\*\*SECONDARY-TO DEVELOP A TECHNIQUE FOR DE-RIVING THREE-DIMENSIONAL TEMPERATURE OF THE ATMOSPHERE FOR OPERATIONAL FORECASTS BY THE MID 1970 S.

#### 31. PRINCIPLES OF OPERATION

INSTRUMENT IS SOMEWHAT SIMILAR TO THE NIMBUS-2 MRIR. ITPR WILL MEASURE IR RADIATION IN FOUR SPECTRAL INTERVALS OF THE 15-MICRON CARBON DIOXIDE BAND, A SPECTRAL INTERVAL OF THE ROTATIONAL WATER VAPOR BAND, AND IN THE 3.8 AND 11-MICRON SPECTRAL WINDOWS. COVER-AGE IS CLUSTER-SAMPLED IN THREE CLUSTERS OF 10 BY 14 INSTANTAN-EOUS FOV'S PER CLUSTER DISTRIBUTED SYMMETRICALLY ABOUT EITHER SIDE OF NADIR BUT STAGGERED BY CLUSTER IN THE ORBITAL DIRECTION. EACH CLUSTER MATRIX CONTAINS 140 RESOLUTION ELEMENTS. MEASURE-MENTS IN THE CARBON DIOXIDE AND WATER VAPOR ABSORPTION BANDS WILL BE USE TO CALCULATE THE TEMPERATURE PROFILES AND THE TOTAL WATER VAPOR IN THE LOWER STRATOSPHERE AND TROPOSHERE BY INVERT-ING THE RADIATIVE TRANSFER EQUATION USING NUMERICAL AND MATH-EMATICAL TECHNIQUES. THE STATISTICAL FLUCTUATIONS OF THE RAD-IATION DATA FROM THE INDEPENDENT RESOLUTION ELEMENTS WILL BE UTILIZED IN THE SOLUTION TO ACCOUNT FOR THE ATTENUATION OF THE CLOUDS IN ADDITION TO THE TWO WINDOW MEASUREMENTS WHICH SHOULD ENABLE CLOUD CONTAMINATION OF THE RADIANCES TO BE DETECTED AND ELIMINATED, THUS PERMITTING ACTUAL DETERMINATION OF TEMPERATURE PROFILES DOWN TO THE EARTH'S SURFACE.

#### 32. PHENOMENA OBSERVED

IR ENERGY EMITTED FROM THE SURFACE AND ATMOSPHERE OF THE EARTH

#### 33. MEASUREMENT RANGE

0-200 ERGS/SEC/SQ-CM/STERADIAN/CM\*\*-1

### 34. PRECISION AND ACCURACY

BETTER THAN C.25 ERG/SEC/SQ-CM/STERADIAN/CM\*\*-1

| 35. SPECTRAL RANGE   | 36. SPECTRAL RESOLUTION 37. TIME CONSTANT  |
|--|--|
| 3.8 TO 11. MICRONS   |  |
| 38. FIELD OF VIEW 39. GROUND SW  |  |
|  | 15 NM FROM 600 NM ALTITUDE   |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION  |  |
| 1.5 DEG 15 NM FROM 600 NM A  |  |
| 42. POINTING ACCURACY 43. POINTING RATE 44. ALT  |  |
| 46. SPECIAL REQUIREMENTS   | SUN-SYNCH HIGH NOON  |
| 15 AUXILIARY TEMPERATURES AND VO   | TACES MONITORED  |
| 47. COMPONENTS   | LIAGES MUNITIJKEU  |
| RADIOMETER WITH ASSOCIATED OPTIC   | C DITIC ELECTRONIC DACAGE  |
|  | IER 51. STANDBY POWER 52. PEAK POWER 53. MTBF  |
| 35 LB 0.84 CU FT 25 WAT  | and the state of t |
|  | THERMAL<br>ERFERENCE 58. SHIELDING   |
| The state of the s | NSITIVE THERM. STBLZD TO 25+-5C  |
| 59. CALIBRATION 60. DATA RE  |  |
| BLACK BODY; SPACE VIEW DELAYED   | TELEMETRY CONTINUOUS   |
| 62. TELEMETRY REQUIREMENTS   |  |
| IR DATA - SEVEN 10-BIT WORDS 2.5   | TIMES PER SECOND   |
|  | . Straight are supported   |
|  |  |
| 63. ADVANTAGES AND LIMITATIONS   |  |
| OBSERVATIONS OVER BROKEN CLOUDS  |  |
| ATURE PROFILE DOWN TO GROUND; MO   | VING PARTS.  |
| 64. REFERENCES   |  |
| 1) SMITH, W.L.: MEASUREMENT OF A   |  |
| DITY PROFILES WITH AN INFRARED T   |  |
| ESSA PROPOSAL, FEB 68. ***2) CHAN  | EY, ET AL: TECH REPORT UNDER   |
| CONTRACT NASR-54(03).  |  |
|  |  |
| 65. HISTORICAL REMARKS   |  |
|  |  |
| SIMILAR TO THE NIMBUS 2 MRIR.  |  |
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### INSTRUMENT RESUME NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER

|          | GREENBE | LI, ND. | 20//1 |
|----------|---------|---------|-------|
| 1. TITLE |         |         |       |
|          |         |         |       |

L-BAND RADIOMETER: EARTH RESOURCES EXPERIMENT

2. ACRONYM 3. EXP NO LBR S-194

(TITLE CONT.) PACKAGE (EREP)

4. RESUME DATE VERSION 09/01/72 0004

7. ORGANIZATION 8. TELEPHONE 6. PRINCIPAL INVESTIGATOR MANNED SPACECRAFT CENTER 713-483-0123 EVANS. D. 10. ORGANIZATION 11. TELEPHONE 9. CO-INVESTIGATOR

| 12. CONTRACT<br>TYPE | 13. CONTRACT N | UMBER  | 14. FLASH INDEX | 15. START<br>DATE | 16. <sup>C</sup> | OMPLETION 17. | . STATUS           |               |
|----------------------|----------------|--------|-----------------|-------------------|------------------|---------------|--------------------|---------------|
|                      |                |        |                 |                   |                  |               | E                  | NG.MODEL      |
| 18. MONITOR          |                | 19. AG | ENCY            | 20. PGM           | OFFICE           | 21. T         | ELEPHONE           |               |
| FISCHET              | TI, T.L.       | NAS    | A HDQTRS        | OA/I              | ERS              | 203           | 2-755-             | 2322          |
| 22. VENDOR           |                |        | 23. LOCATION    |                   |                  |               | 24. FLIGHT<br>DATE | 25. LEAD TIME |
| AIRBOUR              | NE INST. LA    | BS.    |                 |                   |                  |               | 1973               |               |
| 26 INCTOUNA          | ENT TYPE       |        |                 | ·                 |                  |               |                    | 27.           |

26. INSTRUMENT TYPE SECURITY

MICROWAVE RADIOMETER UNC 29. SPACECRAFT 28. APPLICATION **ERSP** SKYLAB-A

#### 30. PURPOSE

PRIMARY-TO MEASURE BRIGHTNESS TEMPERATURE OF THE TERRESTRIAL SURFACE IN ORDER TO COMPILE A COMPREHENSIVE SURFACE BRIGHTNESS TEMPERATURE MAP\*\*\*SECONDARY-TO DETERMINE THE DIELECTRIC CONSTANT AND THE RATIO OF ELECTRICAL-TO-THERMAL EFFECTIVE DEPTH ALONG THE EARTH'S SURFACE BY COMPARING RADIOMETER DATA WITH SIMULTANEOUS MEASUREMENTS MADE AT VARIOUS GROUND LOCATIONS.

#### 31. PRINCIPLES OF OPERATION

THE RADIOMETER IS A LOW-NOISE SWITCHED RADIOMETER UTILIZING GAIN MODULATION TECHNIQUES. A SIGNAL PROCESSOR DETECTS, AMPLIFIER, AND SYNCHRONOUSLY DEMODULATES THE SIGNAL AND PROVIDES A DIGITAL OUTPUT CORRESPONDING TO A 0-350 DEG K INPUT TEMPERATURE RANGE. THE ANTENNA IS A 40-IN SQUARE ARRAY CONSISTING OF 64 FOLDED DI-POLE ELEMENTS. RADIATION EMITTED BY A BODY, DIRECTLY PROPORT-IONAL TO TEMPERATURE IS RECEIVED BY THE ANTENNA- ENERGY IS THEN COUPLED FROM THE ANTENNA TO A CALIBRATION NETWORK PASSING THROUGH A DIODE SWITCH WHICH IS SWITCHING PEIODICALLY BETWEEN THE ANTENNA AND A THERMALLY CONTROLLED REFERENCE LOAD. BY CHANG-ING THE GAIN OF THE RADIOMETER SYSTEM IN SYNCHRONISM WITH THE SWITCHING BETWEEN THE ANTENNA AND THE REFERENCE TERMINATION, THE OUTPUT OF THE RADIOMETER CAN BE NULLED TO ZERO. THUS, WHEN THE RADIOMETER GAIN IS INCREASED BY A FACTOR, Y, THE POWER AT THE OUTPUT OF THE RADIOMETER CAN BE EQUATED FOR BOTH HALVES OF THE SWITCHING CYCLE, RESULTING IN A ZERO SWITCH-RATE FREQUENCY COMPONENT. AS LONG AS THE RADIOMETER OPERATES IN ITS LINEAR REGION, GAIN MODULATION CAN BE APPLIED ANYWHERE BETWEEN ANTENNA AND DETECTOR TO ACHIEVE NULL.

#### 32. PHENOMENA OBSERVED

PASSIVE MICROWAVE EMISSIONS FROM EARTH'S SURFACE

#### 33. MEASUREMENT RANGE

L-BAND

34. PRECISION AND ACCURACY

BETTER THAN 1 DEG K

| 35. SPECTRAL RANGE                     |  | 36. SPECTRAL RE                         |              | 37. TIME CONSTANT  |
|--|--|---|--------------|--|
| 1.4 TO 1.42                            |  |   | DEG K        | 1.0 SECOND   |
| 38. FIELD OF VIEW                      | 39. GROUND SWA   |   |              |  |
|  | 63 NM WID  | TH.80 % DV                              | ERLAP AL     | ONG TRACK  |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES | ······································   |   |              |  |
| 15. DEG 63 NM (HA                      | LF POWER B   | EAM WIDTH.                              | )            |  |
| 42. POINTING ACCURACY 43. POINTING RAT | E 44. ALT  | ITUDE                                   | 45. INCLINA  |  |
|  | 235N   | М                                       | 50           | DEG  |
| 46. SPECIAL REQUIREMENTS               |  |   |              |  |
| ANTENNA & COLD REFEREN                 | CE LOAD RE   | QUIRE UNDB                              | STRUCTE      | FIELD OF VIEW  |
| 47. COMPONENTS                         | appeals a common | 100 100 100 100 100 100 100 100 100 100 |              |  |
| ANTENNA, RECEIVER, REF                 | ERENCE LOAD  |   |              |  |
| 48. WEIGHT 49. VOLUME                  | 50. AVERAGE POW  | ER 51. STANDBY PO                       |              | أساره والمستروب المستروب المستروب المستروب المستروب المستروب |
| 38 LB 10.3 CU FT                       | 10 WATT  |   |              | WATTS  |
| 54. MAGNETIC 56. INTERFERENCE 56. INT  | NUCLEAR 57. INT  | HERMAL<br>REFERENCE 58. S               | HIELDING     |  |
| SOURC/SEN                              |  | ISITIVE                                 |              |  |
| 59. CALIBRATION                        | 60. DATA REC   |   |              | QUENCY OF OBSERVATION  |
| HOTECOLD REFERENCE LOA                 | DS FROM RE   | TURNED TAPE                             | S CONT       | TNUDUS   |
| 62. TELEMETRY REQUIREMENTS             |  |   |              |  |
| NA                                     |  |   |              | •  |
|  |  |   |              |  |
|  |  |   |              |  |
| 63. ADVANTAGES AND LIMITATIONS         | 4  |   |              |  |
| LONG WAVELENGTH OF SYS                 | TEM WILL PR  | ROVIDE MEAS                             | SUREMENT     | S WHICH ARE  |
| LESS AFFECTED BY METED                 | ROLOGICAL (  | CONDITIONS                              | ·<br><u></u> |  |
| 64. REFERENCES                         |  |   |              |  |
| EXPERIMENT IMPLEMENTAT                 | ION PLAN FO  | OR MANNED S                             | PACEFLI      | GHT EXPERIMENT   |
| TITLE: L-BAND MICROWAV                 | E RADIOMETI  | R - SKYLAE                              | 3 4 ERE      | P USER*S   |
| HANDBOOK, NASA/MSC, FE                 | B.1971   |   |              |  |
|  |  |   |              |  |
|  |  |   |              |  |
|  |  |   |              |  |
| 65. HISTORICAL REMARKS                 |  |   | ×            |  |
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# INSTRUMENT RESUME NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT MD. 20771

| GREENBELT, MD. 20771   |  |        |                           |          |               |                          |               |              |           |   |  |
|--|--|--------|---------------------------|----------|---------------|--------------------------|---------------|--------------|-----------|---|--|
| 1. TITLE   |  |        | <b>7.</b>                 |          |               |                          |               | 2. A         | CRONYM    | 3. EXP NO                                     |  |
|  | IANCE INVERSI  | ION E  | XP ER IM                  | ENT      |               |                          |               | LI           | RAIN      | EC1   |  |
| (TITLE CONT.)  |  |        |                           |          |               |                          |               | 4. RI        | SUME DATE | 5.<br>VERSION                                 |  |
|  |  |        |                           |          |               |                          | 09            | /01/7        |           |   |  |
| 6. PRINCIPAL INVESTIGATOR 7. ORGANIZATION 8. TELI  |  |        |                           |          |               |                          | LEPHO         | <u> </u>     |           |   |  |
| BATES, J.  | . C •  | HONE   | YWELL /                   | AEROSI   | PACE          |                          | 612-331-4141  |              |           |   |  |
| 9. CO-INVESTIG   |  |        | SANIZATION                |          |               |                          | 11. TELEPHONE |              |           |   |  |
| KING, DR. JEAN I.F. GCA  |  |        | TECHNOLOGY DIVISION       |          |               |                          |               | 617-275-9000 |           |   |  |
| 12. CONTRACT<br>TYPE   | 13. CONTRACT NUMB  | ER     | 14. FLASH I               | NDEX NU  | MBER          | 15. START<br>DATE        | 16. C         | DATE DATE    | 17. STA1  | TUS .   |  |
|  |  |        |                           |          |               | 01/69                    |               |              | ENG.M     | ODE L   |  |
| 18. MONITOR  | <u> </u>   | 19. AG | ENCY                      |          | 20. PGM       | OFFICE                   | 21. TELEPHONE |              |           |   |  |
|  | SCHARDT, B.B. NASA HDQTRS DA/ERN 202-755-  |        |                           |          |               | -2322                    |               |              |           |   |  |
| 22. VENDOR   |  |        | 23. LOCATI                | <u> </u> |               | 24. FLIGHT 25. LEAD TIME |               |              |           |   |  |
| SANTA BARBARA RES CENTER GOLETA, CALIFORNIA  |  |        |                           |          |               | NIA                      |               | 12/7         |           | MONTHS  |  |
| 26. INSTRUMEN  |  |        |                           |          |               |                          |               |              |           | 27.<br>SECURITY                               |  |
| RADIOMETE  | R. 15-MICRON   | INF    | RARED                     | SCANN    | ING F         | PRECIS                   | 101           | 1            |           | PRO   |  |
| 28. APPLICATIO   |  |        | ·····                     |          | · · · · · · · | 29. SPACE                |               |              |           | <u>, , , , , , , , , , , , , , , , , , , </u> |  |
| MET, ATM-  |  | _      |                           |          | 1             | NIMBUS                   | F             |              |           |   |  |
| 30. PURPOSE  |  |        | <del> </del>              |          |               |                          |               |              |           |   |  |
| PRIMARY-TO TEST INVERSION THEORIES FOR RADIANCE/TEMPERATURE MEA-   |  |        |                           |          |               |                          |               |              |           |   |  |
|  | S ALONG THE  |        |                           |          |               |                          | _             |              | _         |   |  |
| THE ATMOS  |  |        | JRE-ALT                   |          |               |                          |               |              |           | ON A  |  |
| 1  | ASIS OVER AN   |        |                           |          |               |                          |               |              | ATA       |   |  |
| 1  | A FIRST STEP   |        |                           |          |               |                          |               |              |           |   |  |
| i  | TECHNIQUES.  | , Un , | THE OLV                   | L CUI II | L             | U/10 IN M                |               | . 11 i M     |           |   |  |
|  | OF OPERATION   |        |                           |          | <del></del>   |                          |               | ,            |           | <u> </u>                                      |  |
|  | RIMENT WILL (  | ופאחר  | ST OF                     | SPACE    | BORNI         | F MFAS                   | HRF           | MENT         | SOF       |   |  |
| 1  | ALONG A TANG   |        |                           |          |               |                          |               |              |           | IREMENT                                       |  |
| WILL INC   |  |        |                           |          |               |                          |               |              |           |   |  |
| EXPERIMEN  |  |        | D DUT                     |          |               |                          |               |              |           |   |  |
|  | PERATING IN 1  |        |                           |          |               |                          |               |              | -MICE     |   |  |
| BANDWIDT   |  |        |                           |          |               |                          |               |              |           |   |  |
| BANDWIDTH AND A VERTICAL RESOLUTION OF APPROXIMATELY TWO KILO-<br>METERS AT THE EARTH'S HORIZON (SCAN RATE = 1 HZ). A SIMPLE BUT |  |        |                           |          |               |                          |               |              |           |   |  |
| ACCURATE ATTITUDE-DETERMINATION SYSTEM WILL BE USED TO FIX   |  |        |                           |          |               |                          |               |              |           |   |  |
|  |  |        |                           |          |               |                          |               |              |           | •   |  |
|  | ACCURATELY THE LINE OF SIGHT OF THE RADIOMETER TO THE EARTH'S ACTUAL HORIZON. THIS SYSTEM WILL CONSIST OF A SUN-SENSOR-GYRO- |        |                           |          |               |                          |               | _            |           |   |  |
|  | SCOPE-UNIT ALLOWING LINE OF SIGHT TO BE DETERMINED WITH APPROXI-   |        |                           |          |               |                          |               |              |           |   |  |
|  | MATELY TWO-KILOMETER RESOLUTION. THE INFRARED RADIOMETER SUB-  |        |                           |          |               |                          |               |              |           |   |  |
|  | NCLUDES A SCA  |        |                           |          |               |                          |               |              |           |   |  |
|  | CURY-CADMIUM-  |        |                           |          |               |                          |               |              |           |   |  |
|  | PERATED AT A   |        |                           |          |               |                          |               |              |           |   |  |
|  | MAINTAINED   |        |                           |          |               |                          |               |              |           |   |  |
|  | INVERSION TO   |        |                           |          |               |                          |               |              |           |   |  |
|  | CCURATE TEMP   |        |                           |          |               |                          |               |              |           |   |  |
| ATMOS DUE  | RE ABOVE 25 H  | LNAIL  | 1881 - 1985<br>145 - 1985 | TIODE    | OPT           | UU I UK E                | וט :<br>יממ   | - 186<br>    | ICI V     | 14.2  |  |
| PRIMES FACI  | NE MUUVE 20 1  | xm II  | TAN MAS                   | DECIN    | UDI           | ALNEU                    | rst           | AIUU         | JOL T .   |   |  |
| 32. PHENOMEN   | IA OBSERVED  |        |                           |          |               |                          |               |              |           | <del></del> , -                               |  |
| IR ENERGY EMITTED BY ATMOSPHERE ALONG LINE OF SIGHT  |  |        |                           |          |               |                          |               |              |           |   |  |
| 33. MEASUREMENT RANGE  |  |        |                           |          |               |                          |               |              |           |   |  |
|  |  | 00 T   | 1 1 122                   | n to     | 270           | DECDEE                   | · ·           | (E1 \/ 1     | TNI Y     |   |  |
| A DYNAMIC RANGE OF 700 TO 1 (220 TO 270 DEGREES KELVIN)  34. PRECISION AND ACCURACY  |  |        |                           |          |               |                          |               |              |           |   |  |
| L  |  |        |                           |          |               |                          |               |              |           |   |  |

TEMPERATURE WITHIN 5 CENTIGRADE DEGREES. ALTITUDE WITHIN 1

| 35. SPECTRAL RANGE                              | · · · · · · · · · · · · · · · · · · · | 36. SPECTRAL RESOL                    | UTION    | 37. TIME CONSTANT    |  |  |  |  |  |  |
|---|---------------------------------------|---------------------------------------|----------|----------------------|--|--|--|--|--|--|
| 14.0 TO 16                                      | .3 MICRONS                            | NA                                    |          |                      |  |  |  |  |  |  |
| 38. FIELD OF VIEW                               | 39. GROUND SWA                        | \TH                                   | v        |                      |  |  |  |  |  |  |
|   | DEG NA                                |                                       |          |                      |  |  |  |  |  |  |
| 40. ANGULAR RESOLUTION 41. SPATIAL              | RESOLUTION                            | · · · · · · · · · · · · · · · · · · · |          |                      |  |  |  |  |  |  |
| NA  |                                       |                                       |          |                      |  |  |  |  |  |  |
| 42. POINTING ACCURACY 43. POINTING              | RATE 44. ALT                          | TUDE 45.                              | INCLINAT | TION                 |  |  |  |  |  |  |
| 1.C DEG   | 8                                     |                                       |          |                      |  |  |  |  |  |  |
| 46. SPECIAL REQUIREMENTS                        |                                       |                                       |          |                      |  |  |  |  |  |  |
| PRELAUNCH WARMUP; CIRCULAR ORBITAL WITHIN 50 KM |                                       |                                       |          |                      |  |  |  |  |  |  |
| 47. COMPONENTS                                  | TTTTUDE ALTON                         | MENT' AND INT                         | COATI    | ON ACCEMBLIES        |  |  |  |  |  |  |
| RADIOMETER; COOLER; A' 48. WEIGHT 49. VOLUME    |                                       | ER 51. STANDBY POWER                  |          |                      |  |  |  |  |  |  |
| 66 LB   | 30 WAT                                |                                       |          | WATTS 6 MON          |  |  |  |  |  |  |
| 54. INTERFERENCE 55. MAGNETIC                   |                                       | HERMAL<br>ERFERENCE 58. SHIE          | ·        | MATTOL O MON         |  |  |  |  |  |  |
| WITH EXERCE                                     |                                       | NSITIVE 200 K                         |          | OUTER SHELL          |  |  |  |  |  |  |
| 59. CALIBRATION                                 | 60. DATA REC                          | <del></del>                           |          | UENCY OF OBSERVATION |  |  |  |  |  |  |
| BLACKBODY STANDARD                              | DELAYED                               | TELEMETRY                             | 2800     | PROFILES/DAY         |  |  |  |  |  |  |
| 62. TELEMETRY REQUIREMENTS                      | 1 Nov. Nov. 100 7 7 7 1 Ave. 107      |                                       |          |                      |  |  |  |  |  |  |
| DATA WILL BE RECORD                             | ED ON NIMBUS                          | HIGH DATA RAT                         | TE STO   | RAGE SYSTEM          |  |  |  |  |  |  |
| (HDRSS) . DATA TRANSM                           |                                       |                                       |          |                      |  |  |  |  |  |  |
| TRACKING STATIONS . HO                          |                                       | ATA IS TRANS                          | AITTED   | ON VHE BEACON        |  |  |  |  |  |  |
| 63. ADVANTAGES AND LIMITATION                   | VS .                                  |                                       |          |                      |  |  |  |  |  |  |
| THE TEST OF INVERSION                           | ON THEORIES W                         | ILL REQUIRE 4                         | SERI     | ES OF SIMULTA-       |  |  |  |  |  |  |
| NEOUS TEMPERATURE SE                            | DUNDINGS ACQU                         | IRED BY ROCKS                         | T PRO    | BES.                 |  |  |  |  |  |  |
| 64. REFERENCES                                  |                                       | · · · · · · · · · · · · · · · · · · · |          |                      |  |  |  |  |  |  |
| 1) NIMBUS E LIMB RAI                            |                                       |                                       | NT, TE   | CHNICAL PRO-         |  |  |  |  |  |  |
| POSAL, V.1, HONEYWEI                            | LL AEROSPACE,                         | FEB. 68.                              |          |                      |  |  |  |  |  |  |
|   |                                       |                                       |          |                      |  |  |  |  |  |  |
|   |                                       |                                       |          |                      |  |  |  |  |  |  |
|   |                                       |                                       |          |                      |  |  |  |  |  |  |
| 65. HISTORICAL REMARKS                          |                                       |                                       |          |                      |  |  |  |  |  |  |
|   |                                       |                                       |          |                      |  |  |  |  |  |  |
|   |                                       | ·                                     |          |                      |  |  |  |  |  |  |
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# NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771

|                                       |                   |        | <b>U</b>                 |         |                   |         |                   |                  |     | _               |  |
|---------------------------------------|-------------------|--------|--------------------------|---------|-------------------|---------|-------------------|------------------|-----|-----------------|--|
| 1. TITLE                              |                   |        |                          |         |                   |         | 2.                | ACRONYN          | 3.  | EXP NO          |  |
| LIMB RAD                              | IANCE INVERS      | ION    |                          |         |                   |         |                   | ۲ I              |     |                 |  |
| (TITLE CONT.                          | )                 |        |                          |         |                   |         | 4. FI             | ESUME DAT        | Ε   | 5.<br>VERSION   |  |
|                                       |                   |        |                          |         | >                 |         | 0.                | 9/01/            | 72  | 0002            |  |
| 6. PRINCIPAL II                       | NVESTIGATOR       | 7. OR  | RGANIZATION 8. TELEPHONE |         |                   |         |                   |                  |     |                 |  |
| GILLE, J. C. FLORIDA STATE UNIVERSITY |                   |        |                          |         |                   |         |                   |                  |     |                 |  |
| 9. CO-INVESTIG                        | ATOR              | 10. OR | GANIZATION               |         |                   | 11. T   | ELEPHO            | NE               |     |                 |  |
| HOUSE, F. B. DREXEL UNIVERSITY        |                   |        |                          |         |                   |         |                   |                  |     |                 |  |
| 12. CONTRACT<br>TYPE                  | 13. CONTRACT NUME | BER    | 14. FLASH INDEX NU       | 16. C   | OMPLETION<br>DATE | 17. STA | TUS               |                  |     |                 |  |
|                                       |                   |        |                          |         |                   |         |                   | PROP             | OS. | A L             |  |
| 18. MONITOR                           |                   | 19. AG | ENCY                     | 20. PGN | OFFICE            | 21. 1   | ELEPH             | ELEPHONE         |     |                 |  |
| SCHARDT,                              | 8.B.              | NAS    | A HDQTRS                 | OA/     | EŔN               | 20      | 2-75              | 5-232            | 2   |                 |  |
| 22. VENDOR                            |                   |        | 23. LOCATION             |         |                   |         | 24. FLIGH<br>DATE | <sup>7</sup> 25. | LEA | TIME            |  |
|                                       |                   |        |                          |         |                   |         | 19                | 74               |     |                 |  |
| 26. INSTRUMEN                         | T TYPE            |        |                          |         |                   |         | -                 |                  |     | 27.<br>SECURITY |  |
| RADIOMET                              | ER, IR            |        |                          |         |                   |         |                   |                  |     | UNC             |  |
| 28. APPLICATIO                        | N                 |        |                          |         | 29. SPACE         | CRAF    | T                 |                  |     |                 |  |
| MET, PLAI                             | NETARY ATMOS      | PHER   | ES                       |         | NIMBU             | S-F     |                   |                  |     |                 |  |
| 20 BURDOCE                            |                   |        |                          |         |                   |         |                   |                  |     |                 |  |

PRIMARY-GLOBAL MEASUREMENT OF STRATOSPHERIC TEMPERATURE STRUCTURE AND WATER VAPOR AND OZONE DENSITY DISTRIBUTIONS\*\*\* SECONDARY-CALCULATION OF GEOSTROPIC WINDS FROM TEMPERATURE MEASUREMENTS.

#### 31. PRINCIPLES OF OPERATION

A SCANNING IR RADIOMETER COUPLED WITH AN ATTITUDE REFERENCE UNIT WILL PRODUCE CALIBRATED RADIANCE PROFILES IN FOUR SPECTRAL IN-TERVALS BY MEASURING RADIATION EMANATING FROM AN ATMOSPHERIC PATH TANGENT TO A GEOCENTRIC CIRCLE. THE SINGLE AXIS ATTITUDE REFERENCE UNIT MEASURES THE EFFECTS OF SPACECRAFT MOTION ON THE RADIOMETER LINE OF SIGHT. PRECISE RELATIVE POINTING DIRECTION IS USED IN THE INFERENCE OF TEMPERATURE. OZONE AND WATER VAPOR DISTRIBUTIONS AS FUNCTIONS OF PRESSURE; WHEN COMBINED WITH MET-EOROLOGICAL (OR CLIMATOLOGICAL) DATA, THE GEOMETRIC HEIGHT SCALE IS OBTAINED. THE INSTRUMENT CONSISTS OF A RADIOMETER FRAME HOUSING ASSEMBLY AND INTERFACE ELECTRONICS UNIT. THE FORMER IN-CLUDES A TELESCOPE ASSEMBLY, SOLID CRYOGEN AND DETECTOR, DETEC-TOR BIAS AND PREAMP ELECTRONICS, AND ATTITUDE REFERENCE GYPO. THE TELESCOPE INCLUDES A BAFFLE SYSTEM, SCANNING MIRPOR, COLLIM-ATOR TUNING FORK CHOPPERS, RELAY OPTICS, AND IN-FLIGHT CALIBRA-TION SUBASSEMBLY. THE SOLID CRYOGEN COOLER ASSEMBLY CONTAINS A PROTECTIVE WINDOW AT AMBIENT TEMPERATURE, COLD RELAY LENSES AND THE ARRAY OF HG-CD-TE DETECTORS WITH FILTERS DEPOSITED ON THEM, AS WELL AS THE METHANE PRIMARY CRYOGEN (65K) AND AMMONIA SECOND-ARY (165K).

# 32. PHENOMENA OBSERVED

HORIZON'S EMITTED RADIANCES IN FOUR IR SPECTRAL REGIONS

33. MEASUREMENT RANGE

8.8-10.1, 14.6-15.9,14.2-17.1, 20-25 MICRONS

34. PRECISION AND ACCURACY

TEMP +-3 DEG K, WIND +-7 M/SEC, OZONE +- 18%, WATER VAPOR + 53%.

| 35. SPECTRAL RANGE  |   | 36. SPECTRA         | AL RESOL       | UTION                                 | 37. TIME                              | CONSTANT    |
|---|---|---------------------|----------------|---------------------------------------|---------------------------------------|-------------|
| 8.8 TO 25   | MICRONS                                 |                     |                |                                       |                                       |             |
| 38. FIELD OF VIEW   | 39. GROUND SWA                          | \TH                 |                |                                       |                                       |             |
|   |   |                     |                |                                       |                                       |             |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESO                         | DLUTION                                 |                     |                |                                       |                                       |             |
| To pay  |   |                     | <del></del>    |                                       |                                       |             |
| 42. POINTING ACCURACY 43. POINTING RATI                         |   |                     |                | INCLINA                               |                                       | <del></del> |
| 46. SPECIAL REQUIREMENTS  |   | CIRCULA             | R SU           | 1 N - 2 A                             | NCH RE                                | TROGRADE    |
| CRYOGENIC TEMPERATURES  | MIICT RE M                              | ATRITATAL           | 50             |                                       |                                       |             |
| 47. COMPONENTS  | MUST BE M                               | AINIAIN             | C ()           | · · · · · · · · · · · · · · · · · · · |                                       |             |
| RADIOMETER, COOLER, EL  | ECTRONICS                               |                     |                |                                       |                                       |             |
| 48. WEIGHT 49. VOLUME   | 50. AVERAGE POW                         | ER 51. STAND        | BY POWER       | 52. PEA                               | K POWER                               | 53. MTBF    |
| 89 LB 3.2 CU F  | T 37 WAT                                | TS                  |                | · · · · · · · · · · · · · · · · · · · |                                       | <u> </u>    |
| 54. INTERFERENCE 55. MAGNETIC 56. INTERFERENCE 56. INTERFERENCE | UCLEAR 57. T                            | HERMAL<br>ERFERENCE | .58. SHIE      | LDING                                 | ·                                     |             |
|   | SE                                      | NSITIVE             |                |                                       |                                       |             |
| 59. CALIBRATION   | 60. DATA REC                            | OVERY               |                | 61. FRE                               | QUENCY OF (                           | DBSERVATION |
|   | TELEMET                                 | RY                  |                | CON                                   | TINUOU                                | <u>S</u>    |
| 62. TELEMETRY REQUIREMENTS                                      |   |                     | and the second |                                       |                                       |             |
|   |   |                     |                |                                       |                                       | •           |
|   |   |                     |                |                                       |                                       |             |
| 63. ADVANTAGES AND LIMITATIONS                                  |   |                     | *****          |                                       |                                       |             |
|   | SECENT CYC                              | VITE TO AAL         | T ADVA         | NOFE                                  | 0.450                                 |             |
| DATA OBTAINED WILL REPI   |   |                     |                |                                       |                                       |             |
| 64. REFERENCES  | NG SULUTIO                              | V UP MAI            | NY UUI         | STANL                                 | JING P                                | KUBLEMS.    |
| PRELIMINARY DATA SHEET  | EOD NITHBU                              | S-E NO              | / 10           | 70                                    | · · · · · · · · · · · · · · · · · · · |             |
| , weelingstake sata state                                       | 101 NIMDO                               | 3-1 7 140           | V • • 1 7      | ( <del>( )</del>                      |                                       |             |
|   |   |                     |                |                                       |                                       |             |
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| 65. HISTORICAL REMARKS  |   |                     |                |                                       |                                       |             |
|   |   | · · · · ·           |                |                                       |                                       |             |
|   |   |                     |                |                                       |                                       |             |
|   |   |                     |                |                                       |                                       |             |
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|                            |         | GREENBELT, MD. 20771   |                   |                |             |      |        |
|----------------------------|---------|------------------------|-------------------|----------------|-------------|------|--------|
| . TITLE                    |         |                        |                   | 2.             | ACRONYM     | 3. E | XP NO  |
| OW-RESOLUTION INFRAF       | ≀ED I   | RADIOMETER             |                   | L              | RIR         |      |        |
| (TITLE CONT.)              |         |                        | *                 | 4.1            | RESUME DATE | 5    | ERSION |
|                            | <u></u> |                        |                   | 0              | 9/01/7      | 72 ' | 7007   |
| . PRINCIPAL INVESTIGATOR   | 7. OR   | GANIZATION             |                   | 8. TELEPHO     | ONE         |      |        |
| MCDONALD, T.               | NES     | C/NOAA                 |                   | 202-65         | 655-4000    |      |        |
|                            | 10. OR  | GANIZATION             |                   | 11. TELEPH     | ONE         |      |        |
|                            |         |                        |                   |                |             |      |        |
| CONTRACT 13. CONTRACT NUMB | ER      | 14. FLASH INDEX NUMBER | 15. START<br>DATE | 16. COMPLETION | 17. STA1    | rus  | •      |
| CPFF                       |         |                        |                   |                | POST        | FL   | IGHT   |

 CPFF
 POST FLIGHT

 18. MONITOR
 19. AGENCY
 20. PGM OFFICE
 21. TELEPHONE

 GLOVER, J.C.
 NESC/NOAA
 20.2-655-4000

 22. VENDOR
 23. LOCATION
 24. FLIGHT AGENTY

 UNIVERSITY OF WISCONSIN
 MADISON, WISCONSIN
 10/66

26. INSTRUMENT TYPE

RADIOMETER, FLAT-PLATE IR/VISIBLE LOW-RESOLUTION

27. SECURITY

RADIOMETER, FLAT-PLATE IR/VISIBLE LOW-RESOLUTION

29. SPACECRAFT

28. APPLICATION29. SPACECRAFTMETESSA 3

#### 30. PURPOSE

PRIMARY-TO GATHER DATA TO AID IN DETERMINING: (1) THE GEOGRAPHIC DISTRIBUTION OF ENERGY RADIATED FROM THE EARTH AND THE RELATION-SHIP OF THIS ENERGY TO INCOMING ENERGY FROM THE SUN AND (2) THE REFLECTION AND SCATTERING OF SOLAR RADIATION BY THE EARTH-ATMOSPHERE SYSTEM.

# 31. PRINCIPLES OF OPERATION

THE ESSA FLAT PLATE RADIOMETER SYSTEM. IS DIVIDED INTO 2 BASIC COMPONENTS: A FLAT PLATE RADIOMETER WITH A 180 DEG FOV. AND A FLAT PLATE RADIOMETER EMPLOYING A CONE SHIELD TO MINIMIZE OR RE-MOVE ANY RESPONSE DUE TO DIRECT SOLAR RADIATION (70 DEG FOV). THE HEART OF EACH SENSOR IS A THIN ALUMINUM DISK THERMALLY AND RADIATIVELY ISOLATED FROM ITS MOUNTS. THE DISK TEMPERATURE IS SENSED BY 2 THERMISTORS MOUNTED ON THE BACK SURFACE OF THE DISK. THE HOUSING TEMPERATURES AND THE CONE TEMPERATURES ARE SEPAR-ATELY SENSED AND RECORDED. TWO SPECTRAL RESPONSES ARE PROVIDED FOR THE DISKS BY THE USE OF ANODIZED ALUMINUM OR BLACK PAINT. THE BLACK PAINTED SURFACE WILL RESPOND TO THE SUM OF THE RE-FLECTED SOLAR, DIRECT SOLAR, AND RERADIATED LONG WAVE RADIATION. THE ANOIZED ALUMINUM SENSOR DISKS REFLECT IN THE VISIBLE RANGE BUT ABSORB IR RADIATION IN THE 7 TO 30 MICRON RANGE. THESE RE-SPOND TO THE RADIATED ENERGY FROM THE EARTH AND EXCLUDE TO A HIGH DEGREE THE DIRECT AND REFLECTED SOLAR RADIATION. BOTH DISK TYPES ARE USED WITH BOTH RADIOMETERS SO THAT 4 RADIOMETERS ARE NEEDED TO COMPLETE A SET. TWO SUCH SETS ARE MOUNTED 180 DEG APART ON THE S/C BUT ISOLATED THERMALLY AND RADIATIVELY FROM IT.

#### 32. PHENOMENA OBSERVED

EARTH ALBEDO-ENERGY RADIATED TO SPACE BY EARTH

33. MEASUREMENT RANGE

NEAR UV, VISIBLE, NEAR IR, THERMAL IR

34. PRECISION AND ACCURACY

K DEG IN THERMAL IR

| 35. SPECTRAL RANGE                         | 36. SPECTRAL RESOLUTION  | 37. TIME CONSTANT  |
|--|--|--|
| 0.3 TO 30.0                                | MICRONS  | CONTINUOUS   |
| 38. FIELD OF VIEW                          | 39. GROUND SWATH   |  |
| SEE ITEM 31                                | LIMB-TO-LIMB(4200 NM)FROM  | 750 NM ALTITUDE  |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES     | DLUTION  |  |
| NΔ   |  |  |
| 42. POINTING ACCURACY 43. POINTING RATI    |  | TION   |
|  | MED CIRCULAR SUN-SY  | NCH RETROGRADE   |
| 46. SPECIAL REQUIREMENTS                   |  |  |
| NONE                                       |  |  |
| 47. COMPONENTS                             |  |  |
| 8 SENSORS (THERMISTORS                     | ), ELECTRONICS, RECORDER   | - American Control of the Control of |
| 48. WEIGHT 49. VOLUME                      | 50. AVERAGE POWER 51. STANDBY POWER 52. PEA  | K POWER 53. MTBF   |
| 7 LB 0.75 CU F                             |  | 1 YEAR   |
| 54. INTERFERENCE 56. INTERFERENCE 56. INTE | UCLEAR FERENCE 57. THERMAL SHIELDING   |  |
|  | SENSITIVE FPR THERM  | ALLY ISOLATED  |
| 59. CALIBRATION                            | 33.37.1123337211   | QUENCY OF OBSERVATION  |
|  | DELAYED TELEMETRY CON  | TINUOUS  |
| 62. TELEMETRY REQUIREMENTS                 |  |  |
| 90 KBITS TAPE CAPACITY                     | •  |  |
|  |  |  |
|  |  |  |
| 63. ADVANTAGES AND LIMITATIONS             | - Van Carlo  |  |
| INSTRUMENT IS BROAD RAI                    | NGE, LOW ACCURACY TYPE.  |  |
|  |  |  |
| 64. REFERENCES                             |  |  |
| 1) FINAL ENGINEERING RI                    | PORT TOS A MET SAT SYSTEM.   | VOL 1. RCA   |
|  | RACT NO. NASS-9034, MAY 5.   |  |
|  | PROCESSINGO OF RESOLUTION  |  |
|  | TES. ESSA TECH REPORT NESC-  |  |
|  | . ES 66-54, SEPT 19, 1968.4  |  |
| AVAILABLE FROM NESC. ES                    | The state of the s | ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,  |
| 65. HISTORICAL REMARKS                     |  |  |
| THIS RADIOMETER WILL AL                    | SO FLY ON ITOS A, B, C, AND  | ) 0-   |
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|   |                   | 1      | GREENBELT, MD.     | 20//1   |                                | _             |                   |             |                 |               |  |  |
|---|-------------------|--------|--------------------|---------|--------------------------------|---------------|-------------------|-------------|-----------------|---------------|--|--|
| 1. TITLE  |                   |        |                    |         |                                |               | 2. A              | CRONYM      | 3. 1            | EXP NO        |  |  |
| LOW-RESCI   | LUTION INFRAF     | RED F  | RADIOMETER         |         |                                |               | LR                | IP          |                 |               |  |  |
| (TITLE CONT.                                      |                   |        |                    |         |                                |               | 4. RE             | SUME DATE   |                 | 5.<br>VERSION |  |  |
|   |                   |        |                    |         |                                |               | 09                | /01/        | 72              | <u> </u>      |  |  |
| 6. PRINCIPAL II                                   | NVESTIGATOR       | 7. OR  | GANIZATION         |         |                                | 8. TI         | LEPHO             | NE          |                 |               |  |  |
| MCDUNALD, T. NESC/NOAA 202-655-400                |                   |        |                    |         |                                |               |                   | -4000       |                 |               |  |  |
| 9. CO-INVESTIGATOR 10. ORGANIZATION 11. TELEPHONE |                   |        |                    |         |                                |               |                   |             |                 |               |  |  |
|   |                   |        |                    |         |                                |               |                   |             |                 |               |  |  |
| 12. CONTRACT<br>TYPE                              | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | MBER    | BER 15. START 16. COMPLETION 1 |               |                   |             | rus             |               |  |  |
|   |                   |        |                    |         |                                |               |                   | POST FLIGHT |                 |               |  |  |
| 18. MONITOR                                       | 4 <u>.</u>        | 19. AG | ENCY               | 20. PGA | A OFFICE                       | 21. TELEPHONE |                   |             |                 |               |  |  |
| GLOVER, .   | J.C               | NES(   | CINDAA             |         |                                | 202           | 2-655             | -4000       | )               |               |  |  |
| 22. VENDOR  |                   |        | 23. LOCATION       |         |                                |               | 24 FLIGHT<br>DATE | 25. L       | EAD             | TIME          |  |  |
| UNIVERSI"   | TY OF WISCONS     | SIN    | MADISON, WI        | SCON    | SIN                            |               | 04/6              | 7           |                 |               |  |  |
| OC INCTRINENT TYPE                                |                   |        |                    |         |                                |               |                   |             | 27.<br>SECURITY |               |  |  |
| RADIOMET  | ER, FLAT-PLAT     | re In  | R/VISIBLE LO       | W-RE    | SOLUT                          | ION           |                   |             |                 |               |  |  |
| 28. APPLICATIO                                    | ON                |        |                    |         | 29. SPACE                      | CRAF          | T                 |             |                 |               |  |  |
| MET   |                   |        |                    |         | ESSA                           | 5             |                   |             |                 |               |  |  |
| 30. PURPOSE                                       |                   |        |                    |         |                                |               |                   |             |                 |               |  |  |

PRIMARY-TO GATHER DATA TO AID IN DETERMINING: (1) THE GEOGRAPHIC DISTRIBUTION OF ENERGY RADIATED FROM THE EARTH AND THE RELATION-SHIP OF THIS ENERGY TO INCOMING ENERGY FROM THE SUN AND (2) THE REFLECTION AND SCATTERING OF SOLAR RADIATION BY THE EARTH-ATMOSPHERE SYSTEM.

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### 32. PHENOMENA OBSERVED

ENERGY RADIATED FROM AND REFLECTED BY THE FARTH/ATMOSPHERE

33. MEASUREMENT RANGE

# 34. PRECISION AND ACCURACY

| 35. SPECTRAL      | <u> </u>                     |            |           |           | . SPECTRA | AL RESOL      | UTION       | 37. TIME ( | CONSTANT               |
|-------------------|------------------------------|------------|-----------|-----------|-----------|---------------|-------------|------------|------------------------|
| 0.3               |                              | •0         | MICR      |           |           |               |             | L          |                        |
| 38. FIELD OF V    |                              |            |           | D SWATH   |           |               |             |            | <del></del>            |
| SEE ITEM          |                              |            |           | O-LIM     | IB (420   | O NM)         | FROM        | 750 NM     | ALTITUDE               |
| 40. ANGULAR RES   | OLUTION 41. SPATIA           | L RESOLU   | TION      |           |           |               |             |            |                        |
|                   |                              |            |           |           |           |               |             |            |                        |
| 42. POINTING ACCU | JRACY 43. POINTING           | RATE       |           | . ALTITU  |           |               | INCLINA     |            |                        |
|                   |                              |            |           | ED C      | IRCUL     | AR   S        | UN-SY       | NCH R      | ETROGRADE              |
| 46. SPECIAL RE    | QUIREMENTS                   |            |           |           |           | <u>.</u>      |             |            |                        |
| <u></u>           |                              |            |           |           |           |               |             |            | <del></del>            |
| 47. COMPONEN      |                              | 0061       |           | 70011     | 66 5      | <b>ECO 00</b> |             |            |                        |
|                   | S (THERMIST                  |            |           |           |           |               |             | K POWER    | E2 MEDE                |
| 48. WEIGHT        | 49. VOLUME                   | - 5        | U. AVERAC | SEPOWER   | 51. STAND | BY POWER      | 52. PEA     | KPOWER     | 53. MTBF               |
| 54. INTERFERENCE  | 55. MAGNETIC<br>INTERFERENCE | Lec NUCLEA | AR        | 57. THERI | MAL       | En cuis       | 1 51110     |            | <u> </u>               |
| 54. INTERFÉRENCE  | INTERFERENCE                 | 56. NUCLEA | ENCE      | +         |           | 58. SHIE      |             | A 1 1 1/ T | COL ATER               |
| 59. CALIBRATION   |                              | <u> </u>   | EO DAT    |           |           | I F PK        |             |            | SOLATED<br>DBSERVATION |
| JJ. JALIBRATI     | ~.4                          |            |           | A RECOV   | ·····     | TOV           |             |            |                        |
| 62 TELEMETE       | Y REQUIREMENTS               |            | UELA      | ו פט ו    | ELEME     | 115.7         | TON         | TINUOU     | 3                      |
|                   | TAPE CAPAC                   | TTV        |           |           |           |               | ·           |            |                        |
| AE VOITS          | TAPE CAPAC                   | 111.       |           |           |           |               |             |            |                        |
|                   |                              |            |           |           |           |               |             |            |                        |
| 63. ADVANTAG      | ES AND LIMITATIO             | NS         |           |           |           |               |             | <u> </u>   |                        |
|                   | DID NOT GET                  |            | DATA      | CTAD      | TC T      | UIIC T        | TMC E       | 20000      | LIED C                 |
| 1                 | IN MOST RE                   |            |           | JIMA      | 13.       | 1103 1        | 1 19E, C    | 77073      | MENE                   |
| 64. REFERENCE     |                              | AUGUT.     | <u> </u>  |           |           |               |             |            |                        |
| 1) FINAL          | ENGINEERIN                   | G REP      | ORT T     | Λ 2Ω      | MET S     | AT SY         | STEM.       | VOI 1      | P.C.A                  |
| 1                 | ECTRONICS.                   |            |           |           |           |               | -           |            |                        |
|                   | .: OPERATI                   |            |           |           |           |               |             |            |                        |
| 1                 | M ESSA SATE                  |            |           |           |           |               |             |            |                        |
| 1                 | NEWS RELEAS                  |            |           |           |           |               |             |            |                        |
|                   | E FROM NESC                  |            |           |           |           | - / •         | . , , , , , |            | 0414                   |
| 65. HISTORICA     |                              |            | <u> </u>  | <u> </u>  |           |               |             |            |                        |
| THIS RAD          | IOMETER WIL                  | LALS       | O FLY     | ON I      | TOS A     | . B.          | C - AN      | D D.       |                        |
|                   |                              |            |           |           | 1         |               |             | <u> </u>   |                        |
|                   |                              |            |           |           |           |               |             |            |                        |
|                   |                              |            |           |           |           |               |             |            |                        |
|                   |                              |            |           |           |           |               |             |            |                        |
| Ì                 |                              |            |           |           |           |               |             |            |                        |
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| Ì                 |                              |            |           |           |           |               |             |            |                        |
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| 1                 |                              |            |           |           |           |               |             |            |                        |

|  |          | GREENBELT, MD. 2 | 20771   |        |         |          |             |              |  |
|--|----------|------------------|---------|--------|---------|----------|-------------|--------------|--|
| 1. TITLE   | <u> </u> |                  |         |        |         | 2. ACR   | ONYM        | 3. EXP NO    |  |
| LOW-RESOLUTION INFRA   | RED      | RADIOMETER       |         |        |         | LRI      | R           |              |  |
| (TITLE CONT.)  |          |                  |         |        | _       | 4. RESUM | E DATE      | 5.<br>VERSIO |  |
|  |          |                  |         |        |         | 09/      | 01/7        |              |  |
| 6. PRINCIPAL INVESTIGATOR  |          | GANIZATION       |         |        |         | EPHONE   |             |              |  |
| MCDONALD, T.   | NES      | C/NOAA           |         |        | 202-    | -655-    | <u>4000</u> |              |  |
| 9. CO-INVESTIGATOR   | 10. OR   | GANIZATION       |         |        | 11. TEL | EPHONE   |             |              |  |
|  |          |                  |         |        | L       |          |             |              |  |
| 12. CONTRACT NUME  |          |                  |         |        |         |          |             |              |  |
| CPFF   |          |                  |         |        |         |          |             |              |  |
| 18. MONITOR  |          |                  | 20. PGM | OFFICE |         | LEPHONE  |             |              |  |
| GLOVER, J.C. NESC/NOAA 202-655-4000  |          |                  |         |        |         |          |             |              |  |
| 22. VENDOR 23. LOCATION 24. FLIGHT 25. LEAD TIME   |          |                  |         |        |         |          |             | AD TIME      |  |
| UNIVERSITY OF WISCONSIN   MADISON, WISCONSIN -   08/68 NA  26. INSTRUMENT TYPE   |          |                  |         |        |         |          |             |              |  |
|  | TE II    | R/VISIBLE LO     | W-RF    | SOLUT  | LON     |          |             | SECURI       |  |
| RADIOMETER, FLAT-PLATE IR/VISIBLE LOW-RESOLUTION  28. APPLICATION  29. SPACECRAFT  |          |                  |         |        |         |          |             |              |  |
| MET   29. SPACECRAFT   FSSA 7  |          |                  |         |        |         |          |             | <del></del>  |  |
| 30. PURPOSE  |          |                  |         | 334    | •       |          |             |              |  |
| PRIMARY-TO GATHER DA   | TA TI    | D AID IN DET     | ERMI    | VING:  | (1)     | THE      | GENG        | FAPHI        |  |
| DISTRIBUTION OF ENER   | GY R     | ADIATED FROM     | THE     | EARTI  | H AND   | ) THE    | REL         | ATION        |  |
| SHIP OF THIS ENERGY TO INCOMING ENERGY FROM THE SUN AND (2) THE  |          |                  |         |        |         |          |             |              |  |
| REFLECTION AND SCATTERING OF SOLAP PADIATION BY THE EARTH-   |          |                  |         |        |         |          |             |              |  |
| ATMOSPHERE SYSTEM.   |          |                  |         |        |         |          |             |              |  |
|  |          |                  |         |        |         |          |             |              |  |
| 31. PRINCIPLES OF OPERATION  |          |                  |         |        |         |          |             |              |  |
| THE ESSA FLAT PLATE  |          |                  |         |        |         |          |             |              |  |
| COMPONENTS: A FLAT PI  | LATE     | RADIOMETER !     | HTIW    | A 18   | O DEC   | 6 FOV    | <b>,</b> 41 | D A          |  |
| FLAT PLATE RADIOMETE   |          |                  |         |        |         |          |             |              |  |
| MOVE ANY RESPONSE DU   |          |                  |         |        |         |          |             |              |  |
| THE HEART OF EACH SE   |          |                  |         |        |         |          |             |              |  |
| RADIATIVELY ISOLATED   |          |                  |         |        |         |          |             |              |  |
| SENSED BY 2 THERMIST   |          |                  |         |        |         |          |             | DISK         |  |
| THE HOUSING TEMPERATI  |          |                  |         |        |         |          |             | AR -         |  |
| ATELY SENSED AND RECE  |          |                  |         |        |         |          |             |              |  |
| FOR THE DISKS BY THE THE BLACK PAINTED SUI   |          |                  |         |        |         |          |             |              |  |
| FLECTED SOLAR, DIRECT  |          |                  |         |        |         |          |             |              |  |
| THE ANOIZED ALUMINUM   |          |                  |         |        |         |          |             |              |  |
| BUT ABSORB IR RADIAT   |          |                  |         |        |         |          |             |              |  |
| SPOND TO THE RADIATE   |          |                  |         |        |         |          |             |              |  |
|  |          |                  |         |        |         |          |             |              |  |
| HIGH DEGREE THE DIRECT AND PEFLECTED SOLAR RADIATION. BOTH DISK TYPES ARE USED WITH BOTH RADIOMETERS SO THAT 4 RADIOMETERS ARE |          |                  |         |        |         |          |             |              |  |
| NEEDED TO COMPLETE A SET. TWO SUCH SETS ARE MOUNTED 180 DEG  |          |                  |         |        |         |          |             |              |  |
| APART ON THE S/C BUT ISOLATED THERMALLY AND RADIATIVELY FROM IT.   |          |                  |         |        |         |          |             |              |  |
|  |          |                  |         |        |         |          |             |              |  |
| 32. PHENOMENA OBSERVED   |          |                  |         |        |         |          |             |              |  |
| EARTH ALBEDO-ENERGY RADIATED TO SPACE BY EARTH   |          |                  |         |        |         |          |             |              |  |
| 33. MEASUREMENT RANGE  |          |                  |         |        |         |          |             |              |  |
| NEAR UV, VISIBLE, NE   | AR IF    | R, THERMAL IF    | ₹       |        |         |          |             |              |  |
| 34. PRECISION AND ACCURACY   |          |                  |         |        |         |          |             |              |  |
| 5 K DEG IN THERMAL IN  | ۲        |                  |         |        |         |          |             |              |  |

| 35. SPECTRAL RA  | ANGE  |                        |              |  | · · · · · · · · · · · · · · · · · · · |                | 36.      | SPECTRA   | L RE         | SOLU  | TION        | 37. TIME   | E C       | ONST         | ANT    |
|--|-------|------------------------|--------------|--|---------------------------------------|----------------|----------|-----------|--------------|---|-------------|------------|-----------|--------------|--------|
| 0.3  | T     | O                      | 30           | • 0  | MI                                    | CRONS          |          |           |              |   |             |            | <u>co</u> | INT          | INUOUS |
| 38. FIELD OF VIE   | W     |                        |              |  | 39. GRC                               | OUND SWA       | TH       |           |              |   |             |            |           |              |        |
| SEE ITEM   |       |                        |              |  |                                       |                | M        | B (4200   | יא כ         | M)FR  | OM T        | 750 N      | M         | ALT          | TITUDE |
| 40. ANGULAR RESOL  | UTION | 41. SP                 | ATIAL        | RESC   | LUTION                                | J              |          |           |              |   |             |            |           |              |        |
| (A   |       |                        |              |  |                                       |                |          |           |              |   |             |            |           |              |        |
| 42. POINTING ACCUR   | ACY   | 43. POIN               | TING         | RATE   |                                       | 44. ALT        |          |           |              |   | ICLINA      |            |           | . = = .      |        |
|  |       |                        |              |  |                                       | MED            | <u> </u> | IRCULA    | 1 R          | SUN   | 1-84        | 1CH        | RE        | TR           | DGRADE |
| 46. SPECIAL REQ  | UIRE  | MENTS                  |              |  |                                       |                |          | <u>.</u>  |              |   |             |            | _         |              |        |
| NONE   |       |                        |              | n/1 **                                       |                                       |                |          |           | <del>-</del> |   | · · · · · · |            |           |              |        |
| 47. COMPONENTS   |       | UCD M                  | CT           | ODC 1  | <del></del>                           | CCTOO          | 1 7      | CC 0.     | - (0)        | חחה   | <del></del> |            |           | <del>.</del> |        |
| 8 SENSORS 48. WEIGHT 4   |       | DEKM!                  | 151          | UK 2 1                                       |                                       | RAGE POW       |          | 51, STAND |              |   |             | K POWER    |           | 53. M        | ATRE   |
| 7 LB   | 9. VC | 0.75                   | 5 (1         | I ET   |                                       | HAGE POW       | <u> </u> | 31.31ANU  | B1 F01       | WER   3                                       | 2.1 LA      |            | +         |              | YEAR   |
| S4. INTERFERENCE   | 55    | MAGNETIC<br>TERFERENCE |              |  | ICLEAR<br>RFERENCE                    | 57. INT        | HERM     | AL        | 58 9         | SHIELE  | DING        |            |           |              | , ILAN |
| INTERFERENCE   |       | ERFERENCE              |              | INTE   | TFERENCE                              |                |          | ITIVE     |              |   |             | MIX        | LS        | 01.4         | TED    |
| 59. CALIBRATIO   | N     |                        |              | <u>.                                    </u> | 60. 0                                 | DATA REC       |          |           | L-'          | · · · · · · · · · · · · · · · · · · ·         |             | QUENCY OF  |           |              |        |
|  |       |                        |              |  | DE                                    | LAYED          | TI       | ELEMET    | TR Y         | $\neg \neg$                                   | CONT        | TNUO       | ūs        |              |        |
| 62. TELEMETRY REQUIREMENTS   |       |                        |              |  |                                       |                |          |           |              |   |             |            |           |              |        |
| 90 KBITS TAPE CAPACITY.  |       |                        |              |  |                                       |                |          |           |              |   |             |            |           |              |        |
|  |       |                        |              |  |                                       |                |          |           |              |   |             |            |           |              |        |
|  |       |                        |              |  |                                       |                |          |           |              |   |             |            |           |              |        |
| 63. ADVANTAGES AND LIMITATIONS   |       |                        |              |  |                                       |                |          |           |              |   |             |            |           |              |        |
| INSTRUMENT IS BROAD RANGE, LOW ACCURACY TYPE   |       |                        |              |  |                                       |                |          |           |              |   |             |            |           |              |        |
|  |       |                        |              |  |                                       |                |          |           |              |   |             |            |           |              |        |
| 64. REFERENCES   |       |                        |              |  |                                       |                |          |           |              |   |             |            |           |              |        |
| 1) FINAL ENGINEERING REPORT TOS A MET SAT SYSTEM, VOL 1. RCA<br>ASTRO-ELECTRONICS, CONTRACT NO. NAS5-9034, MAY 5, 1967.***2) |       |                        |              |  |                                       |                |          |           |              |   |             |            |           |              |        |
| ſ  |       |                        |              |  |                                       |                |          |           |              |   |             |            |           |              |        |
| RUBIN, L.  |       |                        |              |  |                                       |                |          |           |              |   |             |            |           |              |        |
| DATA FROM  |       |                        |              |  |                                       |                |          |           |              |   |             |            |           | DAT          |        |
| 3) ESSA NI<br>AVAILABLE  |       |                        |              |  |                                       |                | -        |           | 19           | , 19  | /OØ+4       | ***4;      |           | UAI          | А      |
| 65. HISTORICAL   |       |                        | <u>. 3 C</u> | , ES   | 341                                   | MASIT .        | <u> </u> | • • •     | ,            |   | *********   |            |           |              |        |
| THIS RADI  |       |                        | 111          | Λ1   | SO E                                  | V ON           | 1        | TOS A.    | R            | <u> </u>                                      | ANI         | <u> </u>   |           |              |        |
| THIS KADE  | OIIE  | J LIN F                | <u> </u>     | <u> </u>                                     | 30 1                                  | <u>C 1 O:1</u> |          | 105 41    |              | <u>, , , , , , , , , , , , , , , , , , , </u> | Aji         | <i>,</i> , |           |              |        |
|  |       |                        |              |  |                                       |                |          |           |              |   |             |            |           |              |        |
|  |       |                        |              |  |                                       |                |          |           |              |   |             |            |           |              |        |
|  |       |                        |              |  |                                       |                |          |           |              |   |             |            |           |              |        |
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|  |       |                        |              |  |                                       |                |          |           |              |   |             |            |           |              |        |
|  |       |                        |              |  |                                       |                |          |           |              |   |             |            |           |              |        |
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|  |       |                        |              |  |                                       |                |          |           |              |   |             |            |           |              |        |
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| ļ  |       |                        |              |  |                                       |                |          |           |              |   |             |            |           |              |        |
| J  |       |                        |              |  |                                       |                |          |           |              |   |             |            |           |              |        |
|  |       |                        |              |  |                                       |                |          |           |              |   |             |            |           |              |        |

# NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER CREENBELT MD 20771

|  |  |        | GREENBELT, ND. 2   | .0771   |                   |       |                    |                                |         |                 |  |
|--|--|--------|--------------------|---------|-------------------|-------|--------------------|--------------------------------|---------|-----------------|--|
| 1. TITLE   |  |        |                    |         |                   |       | 2. A               | CRONYM                         | 3. E    | XP NO           |  |
| LOW-RESOL  | LUTION INFRAF                          | RED F  | RADIOMETER         |         |                   |       | LR                 | IR                             |         |                 |  |
| (TITLE CONT.                                     | )                                      |        |                    |         |                   |       | 4. RE              | SUME DATE                      | 1       | ERSION          |  |
|  |  |        |                    |         |                   |       | 0.9                | 70177                          | 72]     | 2007            |  |
| 6. PRINCIPAL IN                                  | NVESTIGATOR                            | 7. OR  | GANIZATION         | -       |                   | 8. TI | ELEPHO             | VE                             |         |                 |  |
| MCDONALD, T. NESC/NOAA 202-655-40                |  |        |                    |         |                   |       |                    | -4000                          | )       |                 |  |
| 9. CO-INVESTIG                                   | ATOR                                   | 10. OR | GANIZATION         |         |                   | 11. T | ELEPHO             | PHONE  17. STATUS  POST-FLIGHT |         |                 |  |
|  |  |        |                    |         |                   |       |                    |                                |         |                 |  |
| 12. CONTRACT<br>TYPE                             | 13. CONTRACT NUMB                      | ER     | 14. FLASH INDEX NU | MBER    | 15. START<br>DATE | 16. C | OMPLETION<br>DATE  | 17. STA1                       | rus     |                 |  |
| CPFF   |  |        |                    |         |                   |       |                    | POST-                          | -FL     | IGHT            |  |
| 18. MONITOR                                      |  | 19. AG | ENCY               | 20. PGM | OFFICE            | 21. 7 | I. TELEPHONE       |                                |         |                 |  |
| GLOVEP, .  | J.C.                                   | NES    | CINDAA             |         |                   | 202   | 2-655              | -4000                          | <u></u> |                 |  |
| 22. VENDOR                                       | ······································ |        | 23. LOCATION       |         |                   |       | 24. FLIGHT<br>DATE | 25. L                          | EAD     | ŢIME            |  |
| UNIVERSI   | TY OF WISCONS                          | SIN    | MADISON, WISC      | CONS    | IN                |       | 02/6               | 9 NA                           |         |                 |  |
| 26. INSTRUMEN                                    | T TYPE                                 |        |                    |         |                   |       |                    |                                |         | 27.<br>SECURITY |  |
| RADIOMETER, FLAT-PLATE IR/VISIBLE LOW-RESOLUTION |  |        |                    |         |                   |       |                    |                                |         |                 |  |
| 28. APPLICATIO                                   | N                                      |        |                    | 2       | 9. SPACE          | CRAF  | Τ                  |                                |         |                 |  |
| MET  |  |        |                    |         | ESSA (            | 9     |                    |                                |         |                 |  |
| 30. PURPOSE                                      |  |        |                    |         |                   |       |                    |                                | ,,,,,   |                 |  |

PRIMARY-TO GATHER DATA TO AID IN DETERMINING: (1) THE GEOGRAPHIC DISTRIBUTION OF ENERGY RADIATED FROM THE EARTH AND THE RELATION-SHIP OF THIS ENERGY TO INCOMING ENERGY FROM THE SUN AND (2) THE REFLECTION AND SCATTERING OF SOLAR RADIATION BY THE EARTH-ATMOSPHERE SYSTEM.

### 31. PRINCIPLES OF OPERATION

THE ESSA FLAT PLATE RADIOMETER SYSTEM. IS DIVIDED INTO 2 BASIC COMPONENTS: A FLAT PLATE RADIOMETER WITH A 180 DEG FOV. AND A FLAT PLATE RADIOMETER EMPLOYING A CONE SHIELD TO MINIMIZE OR RE-MOVE ANY RESPONSE DUE TO DIRECT SOLAR RADIATION (70 DEG FOV). THE HEART OF EACH SENSOR IS A THIN ALUMINUM DISK THERMALLY AND RADIATIVELY ISOLATED FROM ITS MOUNTS. THE DISK TEMPERATURE IS SENSED BY 2 THERMISTORS MOUNTED ON THE BACK SURFACE OF THE DISK. THE HOUSING TEMPERATURES AND THE CONE TEMPERATURES ARE SEPAR-ATELY SENSED AND RECORDED. TWO SPECTRAL RESPONSES ARE PROVIDED FOR THE DISKS BY THE USE OF ANODIZED ALUMINUM OR BLACK PAINT. THE BLACK PAINTED SURFACE WILL RESPOND TO THE SUM OF THE RE-FLECTED SOLAR, DIRECT SOLAR, AND RERADIATED LONG WAVE RADIATION. THE ANOIZED ALUMINUM SENSOR DISKS REFLECT IN THE VISIBLE RANGE BUT ABSORB IR RADIATION IN THE 7 TO 30 MICRON RANGE. THESE RE-SPOND TO THE RADIATED ENERGY FROM THE FARTH AND EXCLUDE TO A HIGH DEGREE THE DIRECT AND REFLECTED SOLAR RADIATION. BOTH DISK TYPES ARE USED WITH BOTH RADIOMETERS SO THAT 4 RADIOMETERS ARE NEEDED TO COMPLETE A SET. TWO SUCH SETS ARE MOUNTED 180 DEG APART ON THE S/C BUT ISOLATED THERMALLY AND RADIATIVELY FROM IT.

# 32. PHENOMENA OBSERVED

EARTH ALBEDO-ENERGY RADIATED TO SPACE BY EARTH

33. MEASUREMENT RANGE

NEAR UV, VISIBLE, NEAR IR, THERMAL IR

34. PRECISION AND ACCURACY

5 K DEG IN THERMAL IR

| 35. SPECTRAL RANGE                     |  | 36. SPECTRAL RE  | SOLUTION   | 37. TIME CONSTANT  |
|--|--|--|--|--|
| 0.3 TO 30.0                            | MICRONS  |  |  | CONTINUOUS   |
| 38. FIELD OF VIEW                      | 39. GROUND SWA   | ТН   |  |  |
| SEE ITEM 31                            | LIMB-TO-L  | IMB (4200 N  | M)FROM   | 750 NM ALTITUDE  |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES | OLUTION  |  |  |  |
| NA                                     |  |  |  |  |
| 42. POINTING ACCURACY 43. POINTING RAT |  |  | 45. INCLINA  |  |
|  | MED  | CIRCULAR   | SUN-SY   | NCH RETROGRADE   |
| 46. SPECIAL REQUIREMENTS               |  |  |  |  |
| NONE                                   | The second of th | A CONTRACTOR OF THE PROPERTY O |  |  |
| 47. COMPONENTS                         | · FI FCTDO   |  | 2050   | and the second s |
| 8 SENSORS (THERMISTORS                 |  | NICS RECU  |  | K POWER 53. MTBF   |
| 7 LB 0.75 CU F                         |  | EM SI.SIANDBI PO   | VEN 32.1 LA  | 1 YEAR   |
|  |  | HERMAL<br>ERFERENCE 58.  | SHIELDING  | I IEAR   |
| INTERFERENCE INTERFERENCE INTERFERENCE |  |  |  | ALLY ISOLATED  |
| 59. CALIBRATION                        | 60. DATA REC   |  |  | QUENCY OF OBSERVATION  |
|  |  | TELEMETRY  | LUN  | TINUOUS  |
| 62. TELEMETRY REQUIREMENTS             | TOCCATED   |  | 10011  | 1 to 1 195 part  |
| 90 KBITS TAPE CAPACITY                 |  | - A - A - A - A - A - A - A - A - A - A  |  | A STATE OF THE STA |
|  | •  |  |  |  |
|  |  |  |  |  |
| 63. ADVANTAGES AND LIMITATIONS         |  |  |  | 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  |
| INSTRUMENT IS BROAD RAN                | NGE, LOW A   | CCURACY TY   | PE   |  |
| 64. REFERENCES                         |  |  | -\frac{1}{2} - \ | 91 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -   |
| 1) FINAL ENGINEERING R                 | FPORT TOS  | MET SAT  | SYSTEM.  | VOL.1. RCA   |
| ASTRO-ELECTRONICS, CON                 |  |  | •  |  |
| RUBIN. L.: OPERATIONAL                 |  | -  | •  |  |
| DATA FROM ESSA SATELLI                 |  |  |  |  |
| 3) ESSA NEWS RELEASE NO                | D. ES 66-5   | 4, SEPT 19   | 1968.  | ***4) DATA   |
| AVAILABLE FROM NESC. ES                | SSA. WASH.   | D.C.   |  |  |
| 65. HISTORICAL REMARKS                 |  |  |  | The second second second second  |
| THIS RADIOMETER WILL A                 | SO FLY ON  | ITOS A. B  | C C ANI  | D D.   |
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| 1. TITLE   | •                              |        |       |      |      |       |                |          |         |               | 2. AC        | RONYM    | 3. E | XP NO           |
|--|--------------------------------|--------|-------|------|------|-------|----------------|----------|---------|---------------|--------------|----------|------|-----------------|
| LOW-RESOL  | UTION NONSCA                   | NNIN   | IG R  | ADI  | OME: | TER   |                |          |         |               | LRN          | IR       |      |                 |
| (TITLE CONT.   | )                              |        |       |      |      |       |                |          |         |               | 4. RES       | JME DATE |      | S.<br>VERSION   |
|  |                                |        |       |      |      |       |                |          |         |               | 09/          | 01/7     | 2    | 2004            |
|  |                                |        |       | ATIO | V    |       |                |          | 8. T    | ELEP          | HON          | E        |      |                 |
| HANEL, DE  | ARC                            | SP     | ACE   | FL   | T C  | ENTER | 30             | 1-9      | 82-     | 5042          | ?            |          |      |                 |
| 9. CO-INVESTIGATOR 10. ORGANIZATION 11. TELEPHONE              |                                |        |       |      |      |       |                |          |         |               |              |          |      |                 |
| STAMPFL, DR. R.A. GODDARD SPACE FLT CENTER 301-982-5042        |                                |        |       |      |      |       |                |          |         |               |              |          |      |                 |
|  |                                |        |       |      |      |       | OMPLET<br>DATE | ION 1    | 7. STA1 | US            |              |          |      |                 |
|  |                                |        |       |      |      |       |                |          |         |               | F            | OST      | FL   | IGHT            |
| 18. MONITOR  |                                | 19. AG | ENCY  |      |      |       | 20. PG         | M OFFICE | 21.     | 21. TELEPHONE |              |          |      |                 |
| TEPPER, N  | 1.                             | NASA   | A HD  | QTR  | S    |       | ΩA/            | 'ERD     | 20      | 2-7           | 55-          | 2322     |      |                 |
| 22. VENDOR   |                                |        | 23. L | OCAT | ION  |       |                |          |         | 24. FI<br>D.  | LIGHT<br>ATE | 25. L    | EAD  | TIME            |
| BARNES EN  | GINEERING CO                   | )      | STA   | MFO  | RD,  | CO    | NN.            | 1        |         | 11            | /60          | NA       |      |                 |
| 26. INSTRUMEN  | T TYPE                         | 4      |       |      |      |       |                |          |         |               |              |          |      | 27.<br>SECURITY |
| RADIOMETER, 2-CHANNEL NON-SCANNING LOW-RESOLUTION INFRARED UNC |                                |        |       |      |      |       |                |          |         |               |              |          |      |                 |
| 28. APPLICATIO   | 28. APPLICATION 29. SPACECRAFT |        |       |      |      |       |                |          |         |               |              |          |      |                 |
| MET  |                                | ·      |       |      |      |       |                | TIROS    | 2       |               |              |          |      |                 |
| 30. PURPOSE  |                                |        |       |      |      |       |                |          |         |               |              |          |      |                 |
|  |                                |        |       |      |      |       |                |          |         |               |              |          |      |                 |

PRIMARY-TO MEASURE THE THERMAL AND REFLECTED SOLAR RADIATION FROM THE EARTH, TO PERMIT THE DETERMINATION OF THE APPARENT BLACKBODY TEMPERATURES AND ALBEDO OF THE EARTH.

### 31. PRINCIPLES OF OPERATION

THIS LOW-RESOLUTION NON-SCANNING RADIOMETER WAS FLOWN IN AN IDENTICAL CONFIGURATION ON TIROS 2, 3, AND 4. IT CONSISTS OF 2 DETECTORS. ONE OF THESE IS A BLACK THERMISTOR BOLOMETER DETECTOR AND THE OTHER A WHITE ONE, EACH OF WHICH IS MOUNTED IN THE APEX OF A HIGHLY REFLECTIVE CONE. THE BLACK DETECTOR IS EQUALLY SEN-SITIVE TO REFLECTED SUNLIGHT AND TO LONG WAVE TERRESTRIAL RADIA-TION(0.2 TO 50 MICRONS). THE WHITE DETECTOR IS COATED TO BE RE-FLECTIVE IN THE VISIBLE AND NEAR INFRARED, THUS, IT MEASURES ONLY LONG WAVELENGTH THERMAL RADIATION (5 TO 50 MICRONS). THESE DETECTORS PRESENT THE INSTRUMENTATION PACKAGE WITH RESISTANCES WHICH VARY WITH RADIATION. FROM THE DETECTED VALUES THE HEAT BALANCE OF AN AREA CAN BE COMPUTED. THE FIELD WHEN VIEWING DI-RECTLY BELOW IS PARALLEL TO THE SPIN AXIS AND IS A CIRCLE OF 470 NM DIAMETER (50-DEGREE FIELD OF VIEW). THIS VIEW OBSERVES AN AREA WHICH IS WITHIN THE FIELD OF THE WIDE ANGLE TELEVISION CAMERA. THE OUTPUT OF EACH DETECTOR IS AMPLIFIED, AND THE RESULTING SIG-NAL IS USED TO MODULATE SEPARATE AUDIO-FREQUENCY OSCILLATORS. THIS MODULATED DUTPUT IS PROCESSED THROUGH THE TIME-SHARING SWITCHING CIRCUIT WITH THE OUTPUT OF THE SCANNING RADIOMETER.

### 32. PHENOMENA OBSERVED

THERMAL AND REFLECTED SOLAR RADIATION FROM EARTH

33. MEASUREMENT RANGE

-100 DEG C TO +60 DEG C

34. PRECISION AND ACCURACY

S/N BETTER THAN 30 DB

| 35. SPECTRAL RANGE   | 36. SPECTRAL RESOLUTION 37. TIME CONSTANT  |
|--|--|
| 0.2 TO 50.0 MIC  | CRONS SEE ITEM 31  |
| and the second s | UND SWATH  |
| 50.0 DEG 470 M   | NM DIAM CIRCLE FROM 410 NM ALTITUDE  |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION  |  |
| 50.0 DEG 470 NM DIAM CIP   | RCLE FROM 410 NM ALTITUDE  |
| 42. POINTING ACCURACY 43. POINTING RATE  | 44. ALTITUDE 45. INCLINATION   |
|  | MED CIRCULAR MEDIUM POSIGRADE  |
| 46. SPECIAL REQUIREMENTS   | 7  |
|  |  |
| 47. COMPONENTS   | The second section of the section of the second section of the |
| Z THERMISTORS, REFERENCE RES   | STSTORS. FLECTRONICS   |
|  | RAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF   |
|  | WATTS 30 WATTS   |
| ·  |  |
| 54. INTERFERENCE 55. MAGNETIC 56. NUCLEAR 1. INTERFERENCE  | 57. INTERFERENCE 58. SHIELDING   |
|  | SENSITIVE  |
|  | ATA RECOVERY 61. FREQUENCY OF OBSERVATION  |
| BY REFERENCE RESISTORS DEL   | AYED TELEMETRY   CONTINUOUS  |
| 62. TELEMETRY REQUIREMENTS   | :  |
| 7 FREQUENCY BANDS ARE USED F   | FOR TOTAL IR PACKAGE (LOW + MED IR),   |
| THE 7 CHANNELS HAVE A TOTAL  | WIDTH OF 310 HZ.   |
|  |  |
| 63. ADVANTAGES AND LIMITATIONS   |  |
| STRONG THERMAL COUPLING BETW   | VEEN DETECTOR AND SATELLITE. WHITE   |
|  | TICS INADEQUATE IN SPECTRAL RESPONSE   |
| 64 REFERENCES  |  |
|  | DIATION MEASUREMENTS FROM TIROS 2 MET  |
|  | 061.***2) BANDEEN, W.R.: EXPERIMENTAL  |
| ·  | HERIC PROBING IN THE IR FROM SATS.   |
| I  | **************************************   |
| 1  | 1  |
|  | TN D-614, SEPT. 64.***4)DATA AVAIL-  |
| ABLE FROM WORLD DATA CENTER.   | ASHEVILLE, N.C.  |
| 65. HISTORICAL REMARKS   |  |
| IDENTICAL RADIOMETERS FLOWN  | ON TIROS 2, 3, AND 4   |
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|----------------------|-------------------|--------|---------------------|-------------|-------------------|-------------------|-------------------|--------------------|------|-----------------|
| 1. TITLE             |                   |        |                     |             |                   |                   | 2. /              | ACRONYM            | 3. E | XP NO           |
| LOW-RESOL            | UTION NONSCA      | INNI   | NG RADIOMETER       |             |                   |                   | LF                | NR_                | L    |                 |
| (TITLE CONT.         | )                 |        |                     |             |                   |                   | 4. R              | ESUME DATE         |      | 5.<br>VERSION   |
|                      |                   |        |                     |             |                   |                   | 0.5               | 7/01/              | 72   | 2004            |
| 6. PRINCIPAL IN      | VESTIGATOR        | 7. OR  | GANIZATION          |             |                   | 8. TI             | ELEPHO            | NE                 |      |                 |
| HANEL, DE            | ₹ <b>.</b> R.     | GODE   | DARD SPACE FL       | T C         | ENTER             | 301               | 1-982             | -504               | 2    |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION          |             |                   | 11. T             | ELEPHO            | NE                 |      |                 |
| STAMPFL.             | DR. R.A.          | GODE   | DARD SPACE FL       | T C         | ENTER             |                   |                   | -504               |      |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NUM | <b>UBER</b> | 15. START<br>DATE | 16. <sup>Ct</sup> | OMPLETION<br>DATE | 17. STA            | TUS  |                 |
|                      |                   |        |                     |             |                   |                   |                   | POST               | FL   | IGHT_           |
| 18. MONITOR          |                   | 19. AG | ENCY                | 20. PG      | ) OFFICE          | 21. T             | ELEPH             | ONE                |      |                 |
| TEPPER, N            | 1.                | NASA   | A HDQTRS            | OA/         | EŔD               | 202               | 2-755             | -232               | 2    |                 |
| 22. VENDOR           |                   |        | 23. LOCATION        |             |                   |                   | 24. FLIGH<br>DATE | <sup>†</sup> 25. I | _EAD | TIME            |
| BARNES EN            | GINEERING CO      | )      | STAMFORD, CO        | NN.         |                   |                   | 07/6              | 1 NA               |      |                 |
| 26. INSTRUMEN        | Т ТҮРЕ            |        |                     |             |                   |                   |                   |                    |      | 27.<br>SECURITY |
| RADIOMETE            | ER, 2-CHANNEL     | . NOI  | N-SCANNING LO       | W-R         | E SOL U           | TION              | I INF             | RARE               | D    | UNC             |
| 28. APPLICATIO       |                   |        |                     |             | 29. SPACE         |                   |                   |                    |      |                 |
| MET                  |                   |        |                     |             | TIROS             | 3 -               |                   |                    |      |                 |
|                      |                   |        |                     |             |                   |                   | •                 |                    |      |                 |

10. PURPOSE

PRIMARY-TO MEASURE THE THERMAL AND REFLECTED SOLAR RADIATION FROM THE EARTH, TO PERMIT THE DETERMINATION OF THE APPARENT BLACKBODY TEMPERATURES AND ALBEDO OF THE EARTH.

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THIS LOW-RESOLUTION NON-SCANNING RADIOMETER WAS FLOWN IN AN IDENTICAL CONFIGURATION ON TIROS 2, 3, AND 4. IT CONSISTS OF 2 DETECTORS. ONE OF THESE IS A BLACK THERMISTOR BOLOMETER DETECTOR AND THE OTHER A WHITE ONE, EACH OF WHICH IS MOUNTED IN THE APEX OF A HIGHLY REFLECTIVE CONE. THE BLACK DETECTOR IS EQUALLY SEN-SITIVE TO REFLECTED SUNLIGHT AND TO LONG WAVE TERRESTRIAL RADIA-TION(0.2 TO 50 MICRONS). THE WHITE DETECTOR IS COATED TO BE RE-FLECTIVE IN THE VISIBLE AND NEAR INFRARED, THUS, IT MEASURES ONLY LONG WAVELENGTH THERMAL RADIATION (5 TO 50 MICRONS). THESE DE-TECTORS PRESENT THE INSTRUMENTATION PACKAGE WITH RESISTANCES WHICH VARY WITH RADIATION. FROM THE DETECTED VALUES THE HEAT BALANCE OF AN AREA CAN BE COMPUTED. THE FIELD WHEN VIEWING DI-RECTLY BELOW IS PARALLEL TO THE SPIN AXIS AND IS A CIRCLE OF 470 NM DIAMETER (50-DEGREE FIELD OF VIEW). THIS VIEW OBSERVES AN AREA WHICH IS WITHIN THE FIELD OF THE WIDE ANGLE TELEVISION CAMERA. THE OUTPUT OF EACH DETECTOR IS AMPLIFIED, AND THE RESULTING SIG-NAL IS USED TO MODULATE SEPARATE AUDIO-FREQUENCY OSCILLATORS. THIS MODULATED OUTPUT IS PROCESSED THROUGH THE TIME-SHARING SWITCHING CIRCUIT WITH THE DUTPUT OF THE SCANNING RADIOMETER.

### 32. PHENOMENA OBSERVED

THERMAL AND REFLECTED SOLAR RADIATION FROM THE EARTH

### 33. MEASUREMENT RANGE

-100 DEG C TO +60 DEG C

### 34. PRECISION AND ACCURACY

S/N\_BETTER THAN 30 DB

| 35. SPECTRAL RANGE 36. SPECTRAL RESOLUTION 37. TIME CONSTANT   |          |
|--|----------|
| 0.2 TO 50.0 MICRONS SEE ITEM 31  |          |
| 38. FIELD OF VIEW 39. GROUND SWATH   |          |
| 50.0 DEG 470 NM DIAM CIRCLE FROM 475 NM ALTITUDE   |          |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION  |          |
| 50.0 DEG 470 NM DIAM CIRCLE FROM 475 NM ALTITUDE   |          |
| 42. POINTING ACCURACY 43. POINTING RATE 44. ALTITUDE 45. INCLINATION   | إ        |
| MED CIRCULAR MEDIUM POSIGRAD   | 듸        |
| 46. SPECIAL REQUIREMENTS   | -        |
| 47. COMPONENTS   | -        |
| 2 THERMISTORS, REFERENCE RESISTORS, ELECTRONICS  | $\dashv$ |
| 48. WEIGHT 49. VOLUME 50. AVERAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF                              | +        |
| 2 LB 5 WATTS 30 WATTS  | $\dashv$ |
| 54. INTERFERENCE 55. INTERFERENCE 56. INTERFERENCE 57. INTERFERENCE 58. SHIELDING                              |          |
| SENSITIVE  |          |
| 59. CALIBRATION 60. DATA RECOVERY 61. FREQUENCY OF OBSERVATION   |          |
| BY REFERENCE RESISTORS DELAYED TELEMETRY CONTINUOUS  |          |
| 62. TELEMETRY REQUIREMENTS   |          |
| 7 FREQUENCY BANDS ARE USED FOR TOTAL IR PACKAGE (LOW + MED IR)   | ,        |
| THE 7 CHANNELS HAVE A TOTAL WIDTH OF 310 HZ.   | ł        |
|  |          |
| 63. ADVANTAGES AND LIMITATIONS   |          |
| STRONG THERMAL COUPLING BETWEEN DETECTOR AND SATELLITE. WHITE  |          |
| DETECTOR COATING AND CONE OPTICS INADEQUATE IN SPECTRAL RESPON   | SE       |
| 64. REFERENCES   |          |
| 1) IR AND REFLECTED SOLAR RADIATION MEASUREMENTS FROM TIROS 2 M  |          |
| SAT. NASA TN D-1096, NOV. 1961. ***2) BANDEEN, W.R.: EXPERIMENT  | AL       |
| APPROACHES TO REMOTE ATMOSPHERIC PROBING IN THE IR FROM SATS.  | - 1      |
| NASA TM X-63188, MAY 1968.***3)BARTKO, F., ET.AL.: TIROS LOW   |          |
| RESOLUTION RADIOMETER. NASA TN D-614, SEPT. 64.***4)DATA AVAIL<br>ABLE FROM WORLD DATA CENTER, ASHEVILLE, N.C. | -        |
| 65. HISTORICAL REMARKS   |          |
| IDENTICAL INSTRUMENT FLOWN ON TIROS 2 , 3, AND 4.  |          |
| IDENTIONE INSTRUCTION TEOMS ON TENUS 2 7 37 AND 76   | $\dashv$ |
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# NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771

1. TITLE 2. ACRONYM 3. EXP NO IRNR LOW-RESOLUTION NONSCANNING RADIOMETER (TITLE CONT.) 4. RESUME DATE VERSION 09/01/72 2004 6. PRINCIPAL INVESTIGATOR 7. ORGANIZATION 8. TELEPHONE GODDARD SPACE FLT CENTER 301-982-5042 HANEL, DR. R. 9. CO-INVESTIGATOR 10. ORGANIZATION 11. TELEPHONE STAMPFL, DR. R.A. GODDARD SPACE FLT CENTER 301-982-5042 12. CONTRACT 14. FLASH INDEX NUMBER 15. START DATE 13. CONTRACT NUMBER 16. COMPLETION 17. STATUS POST FLIGHT 19. AGENCY 18. MONITOR 20. PGM OFFICE 21. TELEPHONE TEPPER. M. NASA HDOTES OA/ERD 202-755-2322 24. FLIGHT 25. LEAD TIME 22. VENDOR 23. LOCATION BARNES ENGINEERING CO STAMFORD. CONN. 02/62 NA **26. INSTRUMENT TYPE** SECURITY RADIOMETER, 2-CHANNEL NON-SCANNING LOW-RESOLUTION INFRARED UNC 28. APPLICATION 29. SPACECRAFT MET TIROS 4

30. PURPOSE

PRIMARY-TO MEASURE THE THERMAL AND REFLECTED SOLAR RADIATION FROM THE EARTH, TO PERMIT THE DETERMINATION OF THE APPARENT BLACKBODY TEMPERATURES AND ALBEDO OF THE EARTH.

# 31. PRINCIPLES OF OPERATION

THIS LOW-RESOLUTION NON-SCANNING PADIOMETER WAS FLOWN IN AN IDENTICAL CONFIGURATION ON TIROS 2, 3, AND 4. IT CONSISTS OF 2 DETECTORS. ONE OF THESE IS A BLACK THERMISTOR BOLOMETER DETECTOR AND THE OTHER A WHITE ONE. EACH OF WHICH IS MOUNTED IN THE APEX OF A HIGHLY REFLECTIVE CONE. THE BLACK DETECTOR IS EQUALLY SEN-SITIVE TO REFLECTED SUNLIGHT AND TO LONG WAVE TERRESTRIAL RADIA-TION(0.2 TO 50 MICRONS). THE WHITE DETECTOR IS COATED TO BE RE-FLECTIVE IN THE VISIBLE AND NEAR INFRARED, THUS, IT MEASURES ONLY LONG WAVELENGTH THERMAL RADIATION (5 TO 50 MICRONS). THESE DE-TECTORS PRESENT THE INSTRUMENTATION PACKAGE WITH RESISTANCES WHICH VARY WITH RADIATION. FROM THE DETECTED VALUES THE HEAT BALANCE OF AN AREA CAN BE COMPUTED. THE FIELD WHEN VIEWING DI-RECTLY BELOW IS PARALLEL TO THE SPIN AXIX AND IS A CIRCLE OF 470 NM DIAMETER(50-DEGREE FIELD OF VIEW). THIS VIEW OBSERVES AN AREA WHICH IS WITHIN THE FIELD OF THE WIDE ANGLE TELEVISION CAMERA. THE OUTPUT OF EACH DETECTOR IS AMPLIFIED, AND THE RESULTING SIG-NAL IS USED TO MODULATE SEPARATE AUDIO-FREQUENCY OSCILLATORS. THIS MODULATED OUTPUT IS PROCESSED THROUGH THE TIME-SHARING SWITCHING CIRCUIT WITH THE DUTPUT OF THE SCANNING RADIOMETER.

### 32. PHENOMENA OBSERVED

THERMAL AND REFLECTED SOLAR RADIATION FROM THE EARTH

33. MEASUREMENT RANGE

-100 DEG C TO +60 DEG C

34. PRECISION AND ACCURACY

S/N BETTER THAN 30 DB

| 35. SPECTRAL RANGE                     | 36. SPECTRAL RESOLUTION 37. TIME CONSTANT  |
|--|--|
| 0.2 TO 50.0                            | MICRONS SEE ITEM 31  |
| 38. FIELD OF VIEW                      | 39. GROUND SWATH   |
| 50.0 DEG                               | 480 NM DIAM CIRCLE FROM 450 NM ALTITUDE  |
| 40. ANGULAR RESOLUTION 41, SPATIAL RES |  |
|  | CENTER FROM 450 NM ALT   |
|  |  |
| 42. POINTING ACCURACY 43. POINTING RAT |  |
|  | MED CIRCULAR MEDIUM POSIGRADE  |
| 46. SPECIAL REQUIREMENTS               |  |
|  |  |
| 47. COMPONENTS                         | The state of the s |
| 2 THERMISTORS, REFEREN                 | CE RESISTORS, ELECTRONICS  |
| 48. WEIGHT 49. VOLUME                  | 50. AVERAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF  |
| 2 LB                                   | 5 WATTS 30 WATTS   |
|  | IUCLEAR 57. THERMAL ST. INTERFERENCE 58. SHIELDING   |
| INTERFERENCE INTERFERENCE INTE         |  |
| 59 CALIBRATION                         | SENSITIVE  |
| TOO: ONE IDITATION                     | 0.   |
| BY REFERENCE RESISTORS                 | DELAYED TELEMETRY   CONTINUOUS   |
| 62. TELEMETRY REQUIREMENTS             |  |
| 7 FREQUENCY BANDS ARE                  | USED FOR TOTAL IR PACKAGE (LOW + MED IR).  |
| THE 7 CHANNELS HAVE A                  | TOTAL WIDTH OF 310 HZ.   |
|  |  |
| 63. ADVANTAGES AND LIMITATIONS         |  |
|  | G BETWEEN DETECTOR AND SATELLITE. WHITE  |
| 1                                      |  |
|  | ONE OPTICS INADEQUATE IN SPECTRAL RESPONSE   |
| 64. REFERENCES                         |  |
| I ·                                    | AR RADIATION MEASUREMENTS FROM TIROS 2 MET   |
| SAT. NASA TN D-1096, N                 | DV. 1961.***2) BANDEEN, W.R.: EXPERIMENTAL   |
| APPROACHES TO REMOTE A                 | TMOSPHERIC PROBING IN THE IR FROM SATS.  |
| NASA TM X-63188, MAY 19                | 968.***3)BARTKO, F., ET.AL.: TIROS LOW   |
| RESOLUTION RADIOMETER.                 | NASA TN D-614, SEPT. 64.***4) DATA AVAIL   |
| ABLE FROM WORLD DATA C                 |  |
| 65. HISTORICAL REMARKS                 |  |
|  | LOWN DN TIROS 2, 3, AND 4  |
| IDENTICAL INSTRUMENT F                 | LOWN ON TIROS 2, 3, AND 4  |
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GREENBELT, MD. 20771

| 1. TITLE        |                                       |   |                    |             |                   |         | 2. 4               | CRONYM     | 3.  | EXP NO          |
|-----------------|---------------------------------------|---|--------------------|-------------|-------------------|---------|--------------------|------------|-----|-----------------|
| LOW-RESO        | LUTION OMNID                          | IR EC                                   | TIONAL RADIOM      | TETE        | R                 |         | LF                 | ROR        |     | ·               |
| (TITLE CONT.    |                                       |   |                    |             |                   |         | 4. R               | ESUME DATE |     | 5.<br>VERSION   |
|                 |                                       |   |                    | - X         |                   |         | 0.9                | 9/01/      | _   |                 |
| 6. PRINCIPAL IN | VVESTIGATOR                           | 7. OR                                   | GANIZATION         |             |                   | 8. TI   | ELEPHO             | NE         |     |                 |
| SUOMI, DI       | R. V.F.                               | UNI                                     | VERSITY OF WI      | SCO         | NSIN              | 601     | 8-262              | -593       | 8   |                 |
| 9. CO-INVESTIG  |                                       |   | GANIZATION         | .,          |                   | 11. T   | ELEPHO             | NE         |     |                 |
|                 |                                       |   | •                  |             |                   |         |                    |            |     |                 |
| 12. CONTRACT    | 13. CONTRACT NUMB                     | ER                                      | 14. FLASH INDEX NU | <b>MBER</b> | 15. START<br>DATE | 16. C   | OMPLETION<br>DATE  | 17. STAT   | rus |                 |
|                 |                                       |   |                    |             |                   |         |                    | POST       | FI  | IGHT            |
| 18. MONITOR     |                                       | 19. AG                                  | ENCY               | 20. PG      | M OFFICE          | 21. T   | ELEPHO             | ONE        |     |                 |
| HOLTZ, J        | .R.                                   | NAS                                     | A HDQTRS           | oss         | /SG               | 20      | 2-759              | -232       | 2   |                 |
| 22. VENDOR      | · · · · · · · · · · · · · · · · · · · |   | 23. LOCATION       |             |                   |         | 24. FLIGHT<br>DATE | 25. L      | EAL | TIME            |
| UNIVERSI        | TY OF WISCONS                         | SIN                                     | MADISON, WIS       | CON         | SIN               |         | 10/                | 9 NA       |     |                 |
| 26. INSTRUMEN   |                                       | <del></del>                             |                    |             |                   |         |                    |            |     | 27.<br>SECURITY |
| RADIOMET        | FR. IR OMNID                          | IR EC                                   | TIONAL NON-SC      | ANN         | ING LO            | ) W - I | RE SOL             | UTIO       | N   | UNC             |
| 28. APPLICATIO  |                                       | <del></del>                             |                    |             | 29. SPACE         |         |                    |            |     |                 |
| MET             |                                       | *************************************** |                    |             | EXPLO             | RER     | 7                  |            |     |                 |
| 30. PURPOSE     |                                       |   |                    |             |                   |         |                    |            |     |                 |
|                 | TO MEACHE T                           |   | DOCC MEAT DIVE     | VOCT        | OF T              |         | FAOTI              | 1 4 4 4    |     |                 |

PRIMARY-TO MEASURE THE GROSS HEAT BUDGET OF THE EARTH.\*\*\* SECONDARY-TO DETERMINE HOW MUCH SOLAR ENERGY IS ABSORBED, REFLECTED. AND EMITTED BY THE EARTH AND ITS ATMOSPHERE.

# 31. PRINCIPLES OF OPERATION

EXPERIMENTS SIMILAR TO THIS WERE ALSO FLOWN ON TIROS 3.4. AND 7. ON EXPLORER 7. THREE RADIATION CURRENTS ARE MEASURED WITH SIMPLE BOLOMETERS IN THE FORM OF HOLLOW SILVER HEMISPHERES. THE HEMI-SPHERES ARE THERMALLY ISOLATED FROM, BUT IN CLOSE PROXIMITY TO SPECIALLY ALUMINIZED MIRRORS. THESE MIRROR BACKED BOLOMETERS ARE MOUNTED ON THE EQUATOR OF THE SATELLITE. THE BOLOMETER'S TEMPERA TURE IS MEASURED BY A GLASS COATED BEAD THERMISTOR MOUNTED ON THE HEMISPHERE. ALSO, PROVISION IS MADE TO MEASURE THE TEMPERA-TURE OF THE MIRRORS. TWO OF THE HEMISPHERES HAVE A BLACK COATING AND RESPOND ABOUT EQUALLY TO SOLAR AND TERRESTRIAL RADIATION. A THIRD HEMISPHERE, WHITE, IS MORE SENSITIVE TO TERRESTRIAL RADIA-TION THAN TO SOLAR RADIATION. A FOURTH WITH A GOLD METAL SURFACE IS MORE SENSITIVE TO SOLAR RADIATION THAN TO TERRESTRIAL RADIA-TION. A BLACK SPHERE. ON THE AXIS OF THE SATELLITE AT THE TOP. IS USED TO DETERMINE ANY DETERIORATION IN THE MIRROR SURFACES BY COMPARISON WITH BLACKENED HEMISPHERES. A SMALL TABOR-SURFACED HEMISPHERE, PROTECTED FROM DIRECT SUNLIGHT CAN BE USED TO MEA-SURE REFLECTED SUNLIGHT WHEN THE AXIS OF THE SATELLITE POINTS TO THE EARTH'S SURFACE. THE RADIATION CURRENTS ARE OBTAINED BY USING THESE TEMPERATURES IN HEAT BALANCE EQUATIONS.

### 32. PHENOMENA OBSERVED

SOLAR AND TERRESTRIAL RADIATION

33. MEASUREMENT RANGE

128 <u>D</u>EG K TO 488 DEG K

34. PRECISION AND ACCURACY

| 35. SPECTRAL RANGE             | -                      |  |            | 36        | SPECTRAL R            | SOLUTION                              | 37. TIME | CONSTANT    |
|--------------------------------|------------------------|--|------------|-----------|-----------------------|---------------------------------------|----------|-------------|
| 0.3                            | TO 60                  | 0.0                                    | MICR       |           | NA.                   |                                       | 5        | . SECONDS   |
| 38. FIELD OF VIEW              |                        |  | GROUND     |           |                       |                                       |          |             |
| 30.0                           |                        | DEG 3                                  | 00 NM      | DIA       | 4 CIRCLE              | FROM 3                                | 75 NM    | ALTITUDE    |
| 40. ANGULAR RESOLUTION         | 41. SPATIAL            | RESOLU                                 | TION       |           |                       |                                       |          | •           |
| NA                             |                        |  |            |           |                       |                                       |          |             |
| 42. POINTING ACCURACY          | 43. POINTING           | RATE                                   | 44.        | ALTITU    | DE                    | 45. INCLINA                           | TION     |             |
| NA                             | NA                     |  | M          | ED I      | CCENTRI               | HIGH                                  |          | POSIGRADE   |
| 46. SPECIAL REQUIRE            | EMENTS                 |  |            |           | ·                     |                                       |          |             |
|                                |                        |  |            |           |                       |                                       |          |             |
| 47. COMPONENTS                 |                        |  |            |           | ·                     |                                       |          |             |
| 5 MIRROR-BA                    |                        |  |            |           |                       |                                       |          |             |
|                                | DLUME                  | 5                                      | O. AVERAGE | POWER     | 51. STANDBY PO        | WER 52. PEA                           | KPOWER   | 53. MTBF    |
| 3 LB                           | Macheria               | L BUIGLE                               |            | THERA     | ***                   |                                       |          | 3 YRS       |
| 54. INTERFERENCE 55. IN        | MAGNETIC<br>TERFERENCE | 56. NUCLEA                             | ÊNCE       | 57. THERN |                       | SHIELDING                             |          | 25112000    |
|                                |                        |  |            |           | SITIVE M              |                                       |          |             |
| 59. CALIBRATION                |                        |  | 60. DATA   |           |                       |                                       |          | OBSERVATION |
|                                |                        |  | KEAL       | ILME      | TELEMET               | KA L CON                              | TINUOL   | JS          |
| 62. TELEMETRY REQU             |                        |  | CHRA       | 001       | <b>, ,</b> , <b>-</b> | <u> </u>                              |          | . D. T      |
| DATA SENT O                    |                        |  |            |           |                       |                                       |          |             |
| NATURAL BIN                    | AKY -CUDE              | ט אטא                                  | U. BA      | NUWIL     | TH USED               | FUK TRA                               | MOMIS:   | 21 M 12     |
| 10 HZ.                         | D I MITATIO            | <u></u>                                |            |           |                       |                                       |          |             |
|                                |                        |  | MITER      | TO 1      | TAE WEE               |                                       |          |             |
| NO DATA STO                    |                        | HA LI                                  | WILLED     | 10 1      | TWE MUE               | N SAIELL                              | .1 15 1  | A ATEM OF   |
| RECEIVING S'<br>64. REFERENCES | TATIUN.                | <del></del>                            | <u></u>    |           |                       |                                       |          |             |
| 1) JUNO 2 SU                   | MMADV DD               | OLECT                                  | OEDO       | OT 1      | /AL 1 E               | (01.3050                              | 7 CAT    | NACA        |
| TECH NOTE D                    |                        |  |            | -         |                       |                                       |          |             |
| FOR SATELLI                    | -                      |  |            |           |                       |                                       |          |             |
| 1960.***3)D                    |                        |  |            |           |                       |                                       |          |             |
| CENTER.                        |                        | LAULL                                  | . 11014    | 14434     | (/ (MA ) 1 () (V)     | AL SPACE                              | . SCILI  | WE DATA     |
| O E M C IN C                   |                        |  |            |           |                       |                                       |          |             |
| 65. HISTORICAL REM             | ARKS                   | ······································ |            |           |                       |                                       |          | -           |
| •                              |                        |  |            | W         | 4                     | · · · · · · · · · · · · · · · · · · · |          | <u>-</u>    |
|                                |                        |  | ·······    |           |                       |                                       |          |             |
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| <b>.</b>                       |                        |  |            |           |                       |                                       |          |             |
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|                                |                        |  |            |           |                       |                                       |          |             |
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| l .                            |                        |  |            |           |                       |                                       |          |             |

# NATIONAL AERONAUTICS AND SPACE ADMINISTRATION **GODDARD SPACE FLIGHT CENTER** GREENBELT MD. 20771

|                       |              |        | 31122110231,1  |             |          |                   |                  |                   |            |      |                 |
|-----------------------|--------------|--------|----------------|-------------|----------|-------------------|------------------|-------------------|------------|------|-----------------|
| 1. TITLE              |              |        |                |             |          |                   |                  | 2.                | ACRONYM    | 3.   | EXP NO          |
| LOW-RESOLUTIO         | N OMNIDI     | REC1   | TONAL RAD      | MOIC        | 1ETE     | R                 |                  | LF                | S O B      |      |                 |
| (TITLE CONT.)         |              |        |                |             |          |                   |                  | 4. F              | ESUME DATE |      | 5.<br>VERSION   |
|                       |              |        |                |             |          |                   |                  | 0.0               | 9/01/      |      | 3004            |
| 6. PRINCIPAL INVESTIG | SATOR        | 7. OR  | SANIZATION     |             |          |                   | 8. TI            | ELEPHO            | NE         |      |                 |
| SUOMI, DR. V.         | E.           | UNIV   | ERSITY OF      | W           | SCO      | NSIN              | 608              | 3-262             | 2-593      | 8    |                 |
| 9. CO-INVESTIGATOR    |              | 10. OR | SANIZATION     |             |          |                   | 11. T            | ELEPHO            | ONE        |      |                 |
|                       |              |        |                |             |          |                   |                  |                   |            |      |                 |
| 12. CONTRACT 13. CON  | ITRACT NUMBE | ER     | 14. FLASH INDE | X NU        | MBER     | 15. START<br>DATE | 16. <sup>C</sup> | OMPLETION<br>DATE | 17. STA    | TUS  |                 |
|                       |              |        |                |             |          | <u> </u>          | _ [              |                   | POST       | FL   | IGHT            |
| 18. MONITOR           |              | 19. AG | ENCY           |             | 20. PG   | M OFFICE          | 21. T            | ELEPH             | ONE        |      |                 |
| TEPPER, M.            |              | NASA   | HDQTRS         |             | OA/      | ERD               | 202              | 2-75              | 5-232      | 2    |                 |
| 22. VENDOR            |              |        | 23. LOCATION   |             | . 400000 |                   |                  | 24. FLIGH<br>DATE | 7 25.      | LEAD | TIME            |
| UNIVERSITY OF         | WISCONS      | IN     | MADISON,       | WIS         | SCON     | SIN               |                  | 07/6              | 61 NA      |      |                 |
| 26. INSTRUMENT TYPE   |              |        |                |             |          |                   |                  |                   |            |      | 27.<br>SECURITY |
| RADIOMETER, 1         | R OMNIDI     | R ECT  | TIONAL NO      | <u>v-sc</u> | CANN     | ING LO            | )W-F             | RE SOI            | LUTIO      | N    | UNC             |
| 28. APPLICATION       |              |        |                |             |          | 29. SPACE         | CRAF             | T                 |            |      |                 |
| MET                   |              |        |                |             |          | TIROS             | 3                |                   |            |      |                 |
| 30. PURPOSE           |              |        |                |             |          |                   |                  |                   |            |      |                 |

PRIMARY- TO MEASURE THE GROSS HEAT BUDGET OF THE EARTH.\*\*\* SECONDARY-TO DETERMINE HOW MUCH SOLAR ENERGY IS ABSORBED. RE-FLECTED, AND EMITTED BY THE EARTH AND ITS ATMOSPHERE.

### 31. PRINCIPLES OF OPERATION

THIS EXPERIMENT WAS FLOWN IN AN IDENTICAL CONFIGURATION ON TIROS 3, 4, AND 7, AND WAS ALSO SIMILAR TO ONE ON EXPLORER 7. TWO WIDE ANGLE (55 DEG FOV) LOW-RESOLUTION IR DETECTION DEVICES, EACH COMPOSED OF A BLACK-AND-WHITE BOLOMETER AND A REFLECTING MIRROR, ARE MOUNTED 180-DEGREES APART ON TELESCOPING SUPPORTS WHICH PROJECT FROM THE SIDE OF THE SPACECRAFT. THE MIRRORS SHIELD EACH SENSOR FROM DIRECT RADIATION EMITTED BY THE SATELLITE'S BODY. BOTH BOLOMETERS HAVE A HIGH ABSORPTIVITY TO THE IR RADIATION FROM THE EARTH. THE BLACK BOLOMETER ALSO HAS A HIGH ABSORPTIVITY FOR SOLAR RADIATION. THUS REFLECTED AND EMITTED RADIATION CAN BE SEPARATED. THERMISTORS, FASTENED INSIDE OF THE HEMISPHERIC SHELLS, MEASURE SENSOR TEMPERATURES. BECAUSE OF THE LIMITED TELE-METRY CAPABILITY, MATCHED PAIRS OF THERMISTORS ARE CONNECTED IN SERIES WITH SIMILAR SENSORS ON OPPOSITE SIDES OF THE SPACECRAFT. THEREFORE, THE MEASURED SENSOR TEMPERATURE RECEIVED FROM THE SATELLITE IS AN AVERAGE OF 2 TEMPERATURES FROM MATCHED THER-MISTORS. THE INFORMATION TELEMETERED TO EARTH INCLUDES TEMPER-ATURES OF THE MIRRORS AND SENSORS AND A FIXED RESISTANCE VALUE WHICH ALLOWS ONE TO COMPENSATE FOR DRIFT OF THE ELECTRONICS IN THE SATELLITE.

# 32. PHENOMENA OBSERVED

ABSORBED IRRADIANCE FROM SUN AND EARTH: ENERGY EMITTED FROM EARTH 33. MEASUREMENT RANGE

128 DEG K TO 488 DEG K

34. PRECISION AND ACCURACY

| 35. SPECTRAL F    | ANG  | Ē        |                   | ········· | .,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, |          | 30                   | S. SPECTI    | RAL RI                                  | SOLU     | ITION                                 | 37. TIME  | CONSTA | NT       |
|-------------------|--|----------|-------------------|-----------|---|----------|----------------------|--------------|---|----------|---------------------------------------|-----------|--------|----------|
| 0.3               | -  | TO       | 60                | .0        | MI                                      | CRC      | N N                  | Α            |   |          |                                       | 5         | SEC    | CONDS    |
| 38. FIELD OF VI   | EW   |          |                   |           | 39. GR                                  | OUND     | SWATI                | 1            | . 7,                                    |          |                                       |           |        | !        |
| 55.0              |  |          |                   | DEG       | 500                                     | NM       | DIAM                 | CIRC         | LE                                      | FRO      | M 47                                  | 5 NM A    | LTITO  | JDE      |
| 40. ANGULAR RESC  | LUTIC  | N 41.    |                   |           |   |          |                      |              |   |          |                                       |           | .4     |          |
| NA                |  | NA       | 1                 |           | - M                                     |          |                      |              |   |          |                                       |           |        |          |
| 42. POINTING ACCU | RACY   | 43. P    | OINTING           | RATE      |   | 44.      | ALTIT                | JDE          |   | 45. 1    | NCLINA                                | TION      |        |          |
| NA                | W. U. J. J. J. J. J. J. J. J. J. J. J. J. J. | NA       |                   |           |   | ME       | D C                  | IRCUL        | AR                                      | ME       | DIUM                                  | PC        | SIGRA  | ADE      |
| 46. SPECIAL RE    | QUIR   | EMEN     | TS                |           |   |          |                      | ***          |   |          |                                       |           |        |          |
|                   |  |          |                   |           |   |          |                      |              | 20000                                   |          |                                       | ·         |        |          |
| 47. COMPONEN      | rs   |          |                   |           |   | 3        | n ig i be langeren i |              | - 1900                                  |          | *                                     |           |        |          |
| 2 DETECT          | ION  | DEV      | ICES              | , EL      | ECTR                                    | ONI      | ICS                  |              |   |          |                                       |           |        |          |
| 48. WEIGHT        | 49. V  | OLUM     | IE                | ,         | 50. AV                                  | ERAG     | E POWER              | 51. STAN     | IDBY PO                                 | WER      | 52. PEA                               | K POWER   | 53. MT | BF       |
| 3 LB              | <u> </u>                                     | <u>~</u> | Sentral III. III. |           |   | 1 h      | TTAL                 |              | A CONTRACTOR                            |          |                                       |           |        |          |
| 54. INTERFERENCE  | 55.  | MAGNET   | TIC<br>ENCE       | 56. NE    | JCLEAR<br>RFERENCE                      |          | 57. THEF             | MAL<br>RENCE | 58.                                     | SHIEL    | DING                                  |           |        |          |
|                   | amar annungs A                               |          |                   | unin v. n |   |          | SENS                 | ITIVE        | MI                                      | RRO      | RS SI                                 | HIELD     | SENSO  | OR S     |
| 59. CALIBRATIO    | )N   |          |                   |           | 60.                                     | DATA     | A RECO               |              | · • • • • • • • • • • • • • • • • • • • |          |                                       | QUENCY OF |        |          |
| <del>}</del>      |  |          | n                 |           | DE                                      | LAY      | ED T                 | ELEME        | TRY                                     |          | CON                                   | TINUOL    | JS .   |          |
| 62. TELEMETRY     | / REC  | UIRE     | MENTS             | .,,       | 1                                       |          | <del></del>          |              |   |          |                                       | ···· =    |        |          |
| DATA FROM         |  |          |                   | OTHE      | RIR                                     | FX       | PTS                  | ON-BO        | DARD                                    | AR       | E RE                                  | CORDE     | )      |          |
| CONTINUOL         |  |          |                   |           |   |          |                      |              |   |          |                                       |           |        |          |
| COMMAND F         |  |          |                   |           |   |          |                      |              |   |          |                                       |           |        | j        |
| 63. ADVANTAG      |  |          |                   |           | . 011 C                                 | 70112    | , , ,                | 1 1 2 0 14 3 | / <b>•</b>                              | 7        |                                       |           |        |          |
|                   |  |          |                   |           | <u> </u>                                |          |                      |              |   |          | · · · · · · · · · · · · · · · · · · · | ·         |        |          |
|                   |  |          |                   |           |   |          |                      |              |   |          |                                       |           |        | •        |
| 64. REFERENCE     | S  | ·        | - Olympian - Land | -1.00/    |   |          |                      |              |   |          |                                       |           |        |          |
| 1)RADIATI         |  | BAI      | ANCE              | ΠE        | THE                                     | FAR      | TH F                 | ROM A        | Λ ς Δ                                   | TFI I    | ITE                                   | HOUS      | F. F.  | 8        |
| PHD THES          |  |          |                   |           |   |          |                      |              |   |          |                                       |           |        |          |
| SPACE SCI         | •  |          |                   |           |   |          |                      |              |   |          |                                       |           |        |          |
| 7. GSFC F         |  |          |                   | -         |   |          |                      |              |   |          |                                       |           |        |          |
| REPORT VO         |  |          |                   |           |   |          | •                    |              |   |          |                                       |           |        | *****    |
| AVAILABLE         |  | -        |                   |           |   |          |                      |              |   |          |                                       |           |        | .        |
| 65. HISTORICAL    |  |          |                   | JINAL     | <u> </u>                                | <u> </u> | 3616                 | MUL L        | <i>/</i>                                | <u> </u> | TIL IN                                | INASE     | 73311  | 4        |
| IDENTICAL         |  |          |                   | r EI      | OHN                                     | ON       | TIDO                 | C 3.         | 4.                                      | AND      | 7:5                                   | IMTI AD   | ON F   | Y0 7     |
| IDENTICAL         |  | 1310     | COPILIV           | 1 6       | UWIN                                    | OIL      | 1180                 | 3 24         | 79                                      | AND      | 193                                   | MILAN     | · OIY  | <u> </u> |
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|                   |  |          |                   |           |   |          |                      |              |   |          |                                       |           |        |          |
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|                   |  |          |                   |           |   |          |                      |              |   |          |                                       |           |        |          |

# NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771

| 1. TITLE             |                   |        |                    |         |                   |                  | 2. /                                  | ACRONYM      | 3.   | EXP NO          |
|----------------------|-------------------|--------|--------------------|---------|-------------------|------------------|---------------------------------------|--------------|------|-----------------|
| LOW-RESOI            | LUTION OMNID      | REC    | TIONAL RADIO       | METE    | R                 |                  | LF                                    | OR           |      |                 |
| (TITLE CONT.         | ,                 |        |                    |         |                   |                  | 4. R                                  | ESUME DATE   |      | 5.<br>VERSION   |
|                      |                   |        |                    |         |                   |                  | 05                                    | 7017         | 72   | 0004            |
| 6. PRINCIPAL II      | NVESTIGATOR       | 1      | GANIZATION         |         |                   | 8. TI            | ELEPHO                                | NE           |      |                 |
| SUOMI, DI            | R. V. E.          | UNI    | VERSITY OF W       | ISCO    | NSIN              | 608              | 8-262                                 | <b>-593</b>  | 8    |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION         |         |                   | 11. T            | ELEPHO                                | NE           |      |                 |
|                      |                   |        |                    |         |                   |                  |                                       |              |      |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | MBER    | 15. START<br>DATE | 16. <sup>C</sup> | OMPLETION<br>DATE                     | 17. STA      |      |                 |
|                      |                   |        |                    |         |                   |                  |                                       | POST         | FL   | <u>IGHT</u>     |
| 18. MONITOR          |                   | 19. AG | ENCY               | 20. PGN | OFFICE            | 21. T            | ELEPHO                                | ONE          |      |                 |
| TEPPER, I            | M                 | NAS    | A HDQTRS           | DA/     | ERD               | 202              | 2-755                                 | -232         | 2    |                 |
| 22. VENDOR           |                   |        | 23. LOCATION       |         |                   |                  | 24. FLIGHT<br>DATE                    | 25.          | LEAC | TIME            |
| UNIVERSI.            | TY OF WISCONS     | SIN    | MADISON . WIS      | CONS    | IN -              |                  | 02/6                                  | 2 NA         |      |                 |
| 26. INSTRUMEN        |                   |        |                    |         |                   |                  | · · · · · · · · · · · · · · · · · · · |              |      | 27.<br>SECURITY |
| RADIOMET             | ER, IR OMNID:     | IR EC  | TIONAL NON-S       | CANN    | ING L             | <u> </u>         | RESOL                                 | <u>OITU.</u> | N    | UNC             |
| 28. APPLICATIO       | N                 |        |                    |         | 29. SPACE         | CRAF             | T                                     |              |      |                 |
| MET                  |                   |        |                    |         | TIROS             | 4                |                                       |              |      |                 |
| 30. PURPOSE          |                   |        |                    |         |                   |                  |                                       |              |      |                 |

PRIMARY- TO MEASURE THE GROSS HEAT BUDGET OF THE EARTH.\*\*\*
SECONDARY-TO DETERMINE HOW MUCH SOLAR ENERGY IS ABSORBED, REFLECTED, AND EMITTED BY THE EARTH AND ITS ATMOSPHERE.

#### 31. PRINCIPLES OF OPERATION

THIS EXPERIMENT WAS FLOWN IN AN IDENTICAL CONFIGURATION ON TIROS 3, 4, AND 7, AND WAS ALSO SIMILAR TO ONE ON EXPLORER 7. TWO WIDE ANGLE (55 DEG FOV) LOW-RESOLUTION IR DETECTION DEVICES, EACH COMPOSED OF A BLACK-AND-WHITE BOLOMETER AND A REFLECTING MIRROR. ARE MOUNTED 180-DEGREES APART ON TELESCOPING SUPPORTS WHICH PRO-JECT FROM THE SIDE OF THE SPACECRAFT. THE MIRRORS SHIELD EACH SENSOR FROM DIRECT RADIATION EMITTED BY THE SATELLITE'S BODY. BOTH BOLOMETERS HAVE A HIGH ABSORPTIVITY TO THE IR RADIATION FROM THE EARTH. THE BLACK BOLOMETER ALSO HAS A HIGH ABSORPTIVI-TY FOR SOLAR RADIATION. THUS REFLECTED AND EMITTED RADIATION IS MEASURED. THE SENSOR TEMPERATURES ARE MEASURED BY THERMISTORS FASTENED TO THE INSIDE OF THE HEMISPHERIC SHELLS. THE LIMITED TELEMETRY CAPIBILITY, MATCHED PAIRS OF THERMISTORS ARE CONNECTED IN SERIES WITH SIMILAR SENSORS ON OPPOSITE SIDES OF THE SPACECRAFT. THEREFORE, THE MEASURED SENSOR TEMPERATURE RECEIVED FROM THE SATELLITE IS AN AVERAGE OF 2 TEMPERATURES FROM MATCHED THERMISTORS. THE INFORMATION TELEMETERED TO EARTH IN-CLUDES TEMPERATURES OF THE MIRRORS AND SENSORS AND A FIXED RE-SISTANCE VALUE WHICH ALLOWS ONE TO COMPENSATE FOR DRIFT OF THE ELECTRONICS IN THE SATELLITE.

### 32. PHENOMENA OBSERVED

IR ENERGY ABSORBED FROM SUN AND EARTH AND EMITTED BY THE EARTH

## 33. MEASUREMENT RANGE

128 DEG K TO 488 DEG K

# 34. PRECISION AND ACCURACY

| 35. SPECTRAL I    | RAI | IGE                   |       |             | <del></del> - |      |          |       |              |               |            | 36       | 6. SF         | PECT | RAI                                   | L RE  | SOL  | UTI  | ON       | 37.  | TIM        | E C | ON       | STA   | NT   | 1        |
|-------------------|-----|-----------------------|-------|-------------|---------------|------|----------|-------|--------------|---------------|------------|----------|---------------|------|---------------------------------------|-------|------|------|----------|------|------------|-----|----------|-------|------|----------|
| 0.3               |     | T                     | 0     |             | 60            | 1.0  | )        |       | MI           | CR            | ON         | ١        | A             |      |                                       |       |      |      |          |      | 5          | 5   |          | SEC   | OND  | S        |
| 38. FIELD OF V    | IEV | 1                     |       |             |               |      | Т        | 39. C | SRO          | UNI           | D SV       | VATI     | 4             |      |                                       |       |      |      |          |      |            |     |          |       |      | 1        |
| 55.0              |     |                       |       |             |               | DE   | G        | 47    | 0            | NM            | D          | IAN      | 1 (           | IP   | CL                                    | E     | FR   | M    | 45       | 0 1  | 1M         | AI  | LT       | ITU   | JDE  |          |
| 40. ANGULAR RES   | DLU | TION                  | 41.   | SPA         | TIA           | L R  | ESO      | LUT   | ION          | 1             |            |          |               |      | · · · · · · · · · · · · · · · · · · · |       |      |      |          |      |            |     |          |       |      |          |
| NA                |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      |          |
| 42. POINTING ACCL | JRA |                       |       | OIN.        | TIN           | G RA | ATE      |       |              |               |            | TITU     |               |      |                                       | _     | 1    |      | LINA     |      |            |     |          |       |      | _4       |
| NA                |     |                       | NA    |             |               |      |          | · ,   | ,            | М             | ED         |          | . 11          | KC L | ILA                                   | ĸ     | ME   | : DI | UM       |      | <u> </u>   | 0:  | 511      | GKA   | DE   |          |
| 46. SPECIAL RE    | QU  | IRE                   | MEN   | TS          |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      | <u> </u> |      |            |     |          |       |      | _4       |
|                   |     |                       |       | <del></del> |               |      |          |       | Section 1    |               |            | -date.   | Organization. |      | J                                     |       |      |      |          |      | -          |     |          |       |      |          |
| 47. COMPONEN      |     | KI :                  | n E 1 | TTE         | E             |      | -        | Er    | TD           | ואר           | 17         | <b>c</b> |               |      |                                       |       |      |      |          |      |            |     |          |       |      | -4       |
| 48. WEIGHT        |     |                       | LUN   |             | <i>,</i> L J  | , ,  | <u> </u> | _     |              | -             |            | WER      | 15            | STA  | NDB                                   | Y PO  | WER  | 52   | PEA      | K PC | WE         | R   | 53       | . MT  | BF   | ٠. ۲     |
| 3 LB              | 43  | . •                   | LOI   |             | -             |      |          | +     |              |               | WA         |          | ۲             |      |                                       |       |      |      |          |      |            | -   |          |       |      | 4        |
| 54. INTERFERENCE  | ٦,  | 55. <sub>191</sub> 7. | AGNE? | FIC         |               | 56.  | NU       | CLEAR |              | •             |            | THER     | MAL           | · E  | Т                                     | 58. 9 | SHIE | LDI  | NG       |      |            |     | _        |       |      | 司        |
| MIENTENER         | +   |                       | MICH  | ENCE        |               | †-   |          | EREN  |              |               |            |          |               |      |                                       |       |      |      | S        | HIE  | LD         | 5   | SEI      | V SC  | RS   |          |
| 59. CALIBRATI     | ON  |                       |       |             |               | 1    |          | 16    | 50. C        | DAT           |            | ECO      |               |      |                                       |       |      |      | . FRE    |      |            |     |          |       |      |          |
|                   |     |                       |       |             |               |      |          | 1     | DE           | LA'           | YE         | D T      | EL            | .EM  | ET                                    | RY    |      | C    | ON       | TIN  | iuo        | IU! | <u>S</u> |       |      |          |
| 62. TELEMETR      |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      | MANAGERA |
| DATA FRO          |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      | -        |
| CONTINUO          |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       | AP    | E F  | DR   | P        | LAY  | <b>'BA</b> | CK  | ( (      | NC    |      |          |
| COMMAND           | _   |                       |       |             |               |      | HE       | G     | ₹ <u>O</u> l | JNI           | <u>D :</u> | STA      | T             | ON   | S.                                    |       |      |      |          |      |            |     |          |       |      | _        |
| 63. ADVANTAG      | ES  | ANI                   | LII   | AIT/        | ATIC          | ONS  |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      | _        |
|                   |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      |          |
| or prespensi      |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      | 4        |
| 1) RADIAT         | -   | NI S                  | 2 A I | AN          | <u> </u>      |      | _        | TU    | E 1          | <b>E A </b> ( | ) T :      | <u> </u> | D.C           | \M   |                                       | CA:   | TCI  | 1 7  | TC       |      | <u> </u>   | CC  |          |       |      | 4        |
| PHD THES          |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      | -        |
| SPACE SCI         |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      |          |
| 7. GSFC           |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      |          |
| REPORT VO         |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          | • •   | 1100 | •        |
| AVAILABLE         |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          | SFC   |      |          |
| 65. HISTORICA     |     |                       |       |             |               |      |          |       |              |               |            |          |               |      | **                                    |       |      |      | ****     |      |            |     |          | - *** |      |          |
| IDENTICAL         |     | IN:                   | STR   | MU          | ΙEΝ           | T    | FL       | OWN   | <b>V</b> (   | NC            | T          | RO       | S             | 3,   | 4,                                    | ΑI    | ND.  | 7;   | SI       | 11L  | AR         |     | 3N       | EX    | P 7  | $\Box$   |
| 1                 |     |                       |       |             |               |      |          | _     |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      | - 1      |
| ļ                 |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      | - }      |
|                   |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      | - 1      |
|                   |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      | Ì        |
|                   |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      |          |
| ļ                 |     |                       |       | ,           |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      |          |
|                   |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      |          |
|                   |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      |          |
|                   |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      |          |
|                   |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      | ١        |
|                   |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      |          |
|                   |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      |          |
|                   | ٠   |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      |          |
|                   |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      | -        |
|                   |     |                       |       |             |               | •    |          |       |              | •             |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      |          |
|                   |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      |          |
|                   |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      |          |
|                   |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      | -        |
|                   |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      |          |
|                   |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      |          |
| I                 |     |                       |       |             |               |      |          |       |              |               |            |          |               |      |                                       |       |      |      |          |      |            |     |          |       |      | 1        |

| 1. TITLE             |                   |        |                    |         |                   |                   | 2.                | ACRO   | MYM    | 3. E | XP NO           |
|----------------------|-------------------|--------|--------------------|---------|-------------------|-------------------|-------------------|--------|--------|------|-----------------|
| LOW-RESO             | LUTION OMNID      | IREC'  | TIONAL RADIOM      | METE    | R                 |                   | L                 | ROR    |        |      |                 |
| (TITLE CONT.         | .)                |        |                    |         |                   |                   |                   | RESUME |        |      | 5.<br>VERSION   |
|                      |                   |        |                    |         |                   |                   | 0                 | 9/0    | 1/7    | 2 [  | 0004            |
| 6. PRINCIPAL II      | NVESTIGATOR       | 7. OR  | GANIZATION         |         |                   | 8. TE             | ELEPH             | ONE    |        |      |                 |
| SUOMI, D             | R. V.E.           | UN I   | VERSITY OF WI      | I SC 01 | NSIN              | 60                | 3-26              | 2-5    | 938    |      |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION         |         |                   | 11. T             | ELEPH             | ONE    |        |      |                 |
|                      |                   |        |                    |         |                   |                   |                   |        |        |      |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | MBER    | 15. START<br>DATE | 16. <sup>CC</sup> | OMPLETION<br>DATE |        | TAT    |      |                 |
|                      |                   |        |                    |         |                   |                   |                   | PO     | ST     | FL   | IGHT            |
| 18. MONITOR          |                   | 19. AG | ENCY               | 20. PGM | OFFICE            | 21. T             | ELEPH             | IONE   |        |      |                 |
| TEPPER,              | М.                | NAS    | A HDQTRS           | CA/     | ERD               | 202               | 2 <b>-</b> 75     | 5-2    | 322    |      | _               |
| 22. VENDOR           |                   |        | 23. LOCATION       |         |                   |                   | 24. FLIG<br>DATE  | HT :   | 25. LE | AD   | TIME            |
| UNIVERSI             | TY OF WISCONS     | SIN    | MADISON, WIS       | SCON    | SIN               |                   | 06/               | 63     | NA     |      |                 |
| 26. INSTRUMEN        | IT TYPE           |        |                    |         |                   |                   |                   |        |        |      | 27.<br>SECURITY |
| RADIOMET             | ER, IR OMNID      | IP EC  | TIONAL NON-SO      | CANN    | ING L             | DW-F              | RE SO             | LUT    | ION    |      | UNC             |
| 28. APPLICATIO       | N                 |        |                    |         | 9. SPACE          | CRAF              | T                 |        |        |      |                 |
| MET                  |                   |        |                    |         | TIROS             | 7                 |                   |        |        |      |                 |
| 20 BURBOCE           |                   |        |                    |         |                   |                   |                   |        |        |      |                 |

PRIMARY- TO MEASURE THE GROSS HEAT BUDGET OF THE FARTH.\*\*\*
SECONDARY-TO DETERMINE HOW MUCH SOLAR ENERGY IS ABSORBED, REFLECTED. AND EMITTED BY THE EARTH AND ITS ATMOSPHERE.

# 31. PRINCIPLES OF OPERATION

THIS EXPERIMENT WAS FLOWN IN AN IDENTICAL CONFIGURATION ON TIROS 3. 4. AND 7. AND WAS ALSO SIMILAR TO ONE ON EXPLORER 7. TWO WIDE ANGLE (55 DEG FOV) LOW-RESOLUTION IR DETECTION DEVICES, EACH COMPOSED OF A BLACK-AND-WHITE BOLOMETER AND A REFLECTING MIRROR, ARE MOUNTED 180-DEGREES APART ON TELESCOPING SUPPORTS SO THAT THE SATELLITE DOES NOT INTERFERE WITH THE FIELD-OF-VIEW. THE MIRRORS SHIELD EACH SENSOR FROM DIRECT RADIATION EMITTED BY THE SATELLITE'S BODY. BOTH BOLOMETERS HAVE A HIGH ABSORPTIVITY TO THE IR RADIATION FROM THE EARTH. THE BLACK BOLOMETER ALSO HAS A HIGH ABSORPTIVITY FOR SOLAR RADIATION. THUS BOTH REFLECTED AND EMITTED RADIATION CAN BE MEASURED. THERMISTORS, FASTENED INSIDE OF THE HEMISPHERIC SHELLS. GIVE THEIR TEMPERATURES. BECAUSE OF THE LIMITED TELEMETRY CAPABILITY, MATCHED PAIRS OF THERMISTORS ARE CONNECTED IN SERIES WITH SIMILAR SENSORS ON OPPOSIDE SIDES OF THE SPACECRAFT. THEREFORE, THE MEASURED SENSOR TEMPERATURE RECEIVED FROM THE SATELLITE IS AN AVERAGE OF 2 TEMPERATURES FROM MATCHED THERMISTORS. THE INFORMATION TELEMETERED TO EARTH IN-CLUDES TEMPERATURES OF THE MIRRORS AND SENSORS AND A FIXED RE-SISTANCE VALUE WHICH ALLOWS ONE TO COMPENSATE FOR DRIFT OF THE ELECTRONICS IN THE SATELLITE.

## 32. PHENOMENA OBSERVED

ABSORBED IRRADIANCE FROM SUN AND EARTH; ENERGY EMITTED FROM EARTH
33. MEASUREMENT RANGE

128 DEG K TO 488 DEG K

34. PRECISION AND ACCURACY

| 35. SPECTRAL RANGE                      | 36. SPECTRAL RESOLUT                               | ION 37. TIME CONSTANT       |
|---|--|-----------------------------|
| 0.3 TO 60.0                             | MICRON NA  | 5 SECONDS                   |
| 38. FIELD OF VIEW                       | 39. GROUND SWATH                                   |                             |
| 4                                       | O NM DIAM CIRCLE FROM 4                            | OO NM ALTITUDE              |
| 40. ANGULAR RESOLUTION 41, SPATIAL RESO | LUTION   |                             |
| NA                                      | · · · · · · · · · · · · · · · · · · ·              |                             |
| 42. POINTING ACCURACY 43. POINTING RATE |  | CLINATION                   |
| NA NA                                   | MED CIRCULAR MED                                   | IUM POSIGRADE               |
| 46. SPECIAL REQUIREMENTS                |  |                             |
| 47. COMPONENTS                          |  | <del></del>                 |
| 2 DETECTION DEVICES. EL                 | FCTRONICS  |                             |
| 48. WEIGHT 49. VOLUME                   | · · · · · · · · · · · · · · · · · · ·              | 2. PEAK POWER 53. MTBF      |
| 3 LB                                    |  |                             |
|   | CLEAR 57 THERMAL 58. SHIELD                        | ING                         |
|   | SENSITIVE MIRROR                                   | S SHIELD SENSORS            |
| 59. CALIBRATION                         |  | 1. FREQUENCY OF OBSERVATION |
|   | DELAYED TELEMETRY                                  | CONTINUOUS                  |
| 62. TELEMETRY REQUIREMENTS              |  |                             |
|   | R IR EXPTS ON-BOARD ARE                            |                             |
|   | BIT ON MAGNETIC TAPE FO                            | R PLAYBACK ON               |
| COMMAND FROM ONE OF THE                 | GROUND STATIONS.                                   |                             |
| 63. ADVANTAGES AND LIMITATIONS          |  |                             |
|   |  |                             |
|   |  |                             |
| 64. REFERENCES                          | THE EARTH FROM A CATCLE                            |                             |
|   | THE EARTH FROM A SATELL                            |                             |
|   | 1965.***2)SATELLITE AND                            |                             |
|   | NASA/GSFC,JAN 68.***3)M<br>0-63-99, MAY 63.***4)JU |                             |
|   | 7, NASA TN-D-608, JULY 6                           |                             |
|   | SPACE SCIENCE DATA CEN                             |                             |
| 65. HISTORICAL REMARKS                  | STACE SCIENCE BATA CEN                             | TERT WASA/SSEC.             |
|   | OWN ON TIROS 3,4,AND 7;                            | STMILAR ON EXP 7            |
|   | CAN CH TINGS STITATE TY                            | STITEAR ON CAT              |
|   |  |                             |
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#### INSTRUMENT RESUME NATIONAL AERONAUTICS AND SPACE ADMINISTRATION **GODDARD SPACE FLIGHT CENTER** GREENBELT, MD. 20771 3. EXP NO 2. ACRONYM 1. TITLE MEDIUM-RESOLUTION INFRARED RADIOMETER MRIR 4. RESUME DATE VERSION (TITLE CONT.) 09/01/72 0005 8. TELEPHONE 7. ORGANIZATION 6. PRINCIPAL INVESTIGATOR GODDARD SPACE FLT CENTER 301-982-5042 MCCULLOCH. A. 10. ORGANIZATION 11. TELEPHONE 9. CO-INVESTIGATOR 12. CONTRACT 13. CONTRACT NUMBER 15. START 16. COMPLETION 17. STATUS 14. FLASH INDEX NUMBER POST FLIGHT 20. PGM OFFICE 19. AGENCY 21. TELEPHONE 18. MONITOR HALEY, DR. NASA HDQTRS. OA/ERN 202-755-2322 23. LOCATION 25. LEAD TIME 24. FLIGHT DATE 22. VENDOR GOLETA, CALIFORNIA 05/66 NA SANTA BARBARA RES CTR **26. INSTRUMENT TYPE** 27. SECURITY RADIOMETER. 5-CHANNEL MEDIUM-RESOLUTION IR/VISIBLE SCANNING UNC 28. APPLICATION 29. SPACECRAFT MET NIMBUS 2 30. PURPOSE PRIMARY-TO MEASURE ELECTROMAGNETIC RADIATION EMITTED AND RE-FLECTED FROM THE EARTH AND ITS ATMOSPHERE IN 5 SELECTED WAVE-LENGTH INTERVALS. PARAMETERS TO BE STUDIED ARE: ATMOSPHERIC WATER VAPOR ABSORPTION BAND: SURFACE OR NEAR-SURFACE TEMPERATURE AND CLOUD COVER DATA; RADIATION FROM STRATOSPHERE(CO2) BAND ; HEAT BUDGET OF THE EARTH AND INTENSITY OF REFLECTED SOLAR ENERGY. 31. PRINCIPLES OF OPERATION THE 5 CHANNEL NIMBUS MRIR, USING FILTERS AND BOLOMETER DETECTORS, WAS SIMILAR IN PURPOSE TO THE EARLIER TIROS MRR BUT WAS A NEW INSTRUMENT DESIGN.THE SPECTRAL INTERVALS WERE: 6.4-6.9,10-11,14-16.5.0-30.0.AND 0.2-4.0 MICRONS. THE RADIANT ENERGY FROM THE EARTH IS COLLECTED BY A FLAT SCANNING MIRROR INCLINED AT 45 DEG TO THE OPTICAL AXIS. THE MIRROR ROTATES AT 8 RPM AND SCANS IN A PLANE PERPENDICULAR TO THE DIRECTION OF MOTION OF THE SATEL-LITE. EACH OF THE 5 CHANNELS CONTAINS A 1.7 IN. DIAMETER FOLDED TELESCOPE AND A THERMISTOR BOLOMETER WITH A 2.8 DEG FOV.CALIBRA-TION OF THE IR CHANNELS OCCUR AT 2 POINTS DURING EACH SCAN. COLD SPACE AND THE RADIOMETER HOUSING. THE INCIDENT FLUX FOCUSED ON THE BOLOMETER DETECTOR IS MODULATED AT 60 HZ BY A MECHANICAL CHOPPER TO PRODUCE AN A.C. SIGNAL FROM THE DETECTOR. (REFERENCE ITEMP OF THE RADIOMETER). THE ABSOLUTE TEMP OF THE TARGET IS DE $m{ ilde{-}}$ TERMINED BY INTRODUCING AN ELECTRONIC VOLTAGE IN SUCH A PROPOR-TION THAT A TARGET OF A GIVEN TEMP WILL ALWAYS PRODUCE THE SAME ABSOLUTE VOLTAGE OUTPUT. THE ELECTRICAL SIGNAL FROM THE DETECTOR IS THEN AMPLIFIED AND SYNCHROUNOUSLY DEMODULATED TO YIELD AN ANALOG OUTPUT OF O TO -6.4 VOLTS TO COVER THE DESIRED RANGE OF TARGET TEMPERATURE FOR EACH CHANNEL. 32. PHENOMENA OBSERVED RADIATION FROM THE EARTH AND ITS ATMOSPHERE

34. PRECISION AND ACCURACY

33. MEASUREMENT RANGE

| 35. SPECTRAL RANGE            | All Control of the Co |  | 36. SPECTRAL  | RESOLUTIO   | ON 37. TIME                           | CONSTANT    |
|-------------------------------|--|--|---------------|-------------|---------------------------------------|-------------|
| 0.2 TO                        | 30.0 MI  | CRONS  | SEE ITEN      | 1 31        |                                       |             |
| 38. FIELD OF VIEW             |  | OUND SWA   | f.t f37       | <u> </u>    |                                       | <u> </u>    |
| 2.8                           | DEG 29 N   |  | CIRCLE        | FROM 6      | OO NM AL                              | TITUDE      |
| 40. ANGULAR RESOLUTION 41. SI |  | <del></del>  |               |             |                                       |             |
|                               | NM FROM 600  |  |               | Tee inc     |                                       | 1           |
| 42. POINTING ACCURACY 43. POI | NTING RATE   | 44. ALTI   |               |             | LINATION                              | STOCOLOS    |
| AC CRECIAL REQUIREMENT        | · ·  | MED  | CIRCULAR      | ( 120M-     | SYNCH R                               | RETROGRADE  |
| 46. SPECIAL REQUIREMENTS      | <u> </u>   | - N  | 3. 3.         | <u> </u>    |                                       |             |
| 47. COMPONENTS                |  | The second secon |               |             | · · · · · · · · · · · · · · · · · · · |             |
| RADIOMETER, ELEC              | CTRONICS   |  |               |             |                                       |             |
| 48. WEIGHT 49. VOLUME         | The second of th | ERAGE POWE   | R 51. STANDBY | POWER 52.   | PEAK POWER                            | 53. MTBF    |
| 14 LB                         | The control of the co | 7 WATT   | S             |             |                                       |             |
| 64 INTERFERENCE 56 MAGNETIC   | 56. NUCLEAR  |  |               | 8. SHIELDI  | VG                                    | Y           |
|                               |  | SEN  | SITIVE        |             |                                       |             |
| 59. CALIBRATION               | 60. 1  | DATA REC   | OVERY         | -61         | . FREQUENCY OF                        | OBSERVATION |
| COLD SPACE AND H              | HOUSING DE   | LAYED  | TELEMETE      | RY C        | ONTINUOL                              | IS          |
| 62. TELEMETRY REQUIREM        |  | gin sadii) at  |               |             | <u>k jak siik si</u>                  |             |
| ANALOG SIGNALS                |  |  |               |             |                                       |             |
| 7-BIT DIGITAL DA              | ATA. EACH DA   | TA WOR   | D BIT IS      | THEN        | RECORDED                              | ON TAPE     |
| FOR PLAYBACK.                 |  |  |               |             |                                       |             |
| 63. ADVANTAGES AND LIMI       | سستغيب بنقله فيستعان فيتعالم   |  |               |             |                                       |             |
| IMPROVED SPECTRA              |  |  |               |             |                                       |             |
| SIGNAL LEVEL HAS              | INCREASED_   | ACCUKA   | CY UF DA      | NIA JVE     | K TIKUS                               | MKK .       |
|                               | AS CULDE C   | CEC 1  |               | + 2 L 2 A T | A CATALO                              | C OC CAT-   |
| 1) NIMBUS 2 USER              |  | •  |               |             |                                       | I           |
| ELLITE AND ROCKE              |  |  |               |             |                                       |             |
| SPACE APP. NASA S             |  | •  |               |             |                                       |             |
| MENTS FOR SATELL              | •  |  |               |             |                                       | ľ           |
| FROM NATIONAL SP              | •  | -  |               |             |                                       | ILMOLL      |
| 65. HISTORICAL REMARKS        |  |  |               |             |                                       |             |
| SIMILAR IN PURPO              | SE TO EARLI  | ER TIR   | OS MRR.       | BUT NE      | W DESIGN                              |             |
|                               |  |  |               |             |                                       |             |
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| GREENBELT, MD. 20771  |                   |        |          |          |      |             |                   |         |            |         |            |        |
|---|-------------------|--------|----------|----------|------|-------------|-------------------|---------|------------|---------|------------|--------|
| 1. TITLE  |                   |        |          |          |      |             |                   |         | 2. ACR     | ONYM    | 3. EX      | (P NO  |
| MEDIUM-RE   | SOLUTION INF      | -RARE  | D RAD    | IOME     | TER  |             |                   |         | MRI        | R       |            |        |
| (TITLE CONT.  |                   |        |          |          |      |             |                   |         | 4. RESU    | NE DATE | 5.<br>V    | ERSION |
|   |                   |        |          | <u> </u> |      | 7           |                   |         | 09/        | 01/7    | 2 0        | 005    |
| 6. PRINCIPAL IN   | VESTIGATOR        | 7. OR  | GANIZATI | ON       |      |             |                   | 8. TEI  | EPHONE     |         |            | **     |
| MCCULLOCH   | 1. A.             | GODE   | DARD S   | PACE     | FL   | T CE        | NTER              | 301-    | -982-      | 5042    |            |        |
| 9. CO-INVESTIG  | ATOR              | 10. OR | GANIZATI | ON       |      |             |                   | 11. TE  | LEPHONE    | •       |            |        |
|   |                   |        |          |          |      |             |                   |         |            |         |            |        |
| 12. CONTRACT<br>TYPE  | 13. CONTRACT NUMB | ER     | 14. FLAS | H INDEX  | NUI  | <b>MBER</b> | 15. START<br>DATE | 16. CON | PLETION 17 | . STAT  | US         |        |
|   |                   |        |          |          |      |             |                   |         | 0          | PERA    | TIO        | NAL    |
| 18. MONITOR   | , <u>// - i</u>   | 19. AG | ENCY     |          |      | 20. PGM     | OFFICE            | 21. TE  | LEPHON     | E       |            |        |
| SCHARDT,  | B • B •           | NASA   | A HDQT   | RS       |      | OA/E        | RN                | 202-    | -755-      | 2322    |            |        |
| 22. VENDOR 23. LOCATION 24. FLIGHT DATE 25. LEAD TIME   |                   |        |          |          |      |             |                   |         | ГІМЕ       |         |            |        |
| SANTA BARBARA RES CTR GOLETA, CALIFORNIA 04/69 NA   |                   |        |          |          |      |             |                   |         |            |         |            |        |
| 26. INSTRUMENT TYPE 27. SECURITY  |                   |        |          |          |      |             |                   |         |            |         |            |        |
| RADIOMETER, 5-CHANNEL MEDIUM-RESOLUTION SCANNING IR/VISIBLE UNC                               |                   |        |          |          |      |             |                   |         |            |         |            |        |
| 28. APPLICATION . 29. SPACECRAFT  |                   |        |          |          |      |             |                   |         |            |         |            |        |
| MET NIMBUS 3  |                   |        |          |          |      |             | 5 3               |         |            |         |            |        |
| 30. PURPOSE   |                   |        |          |          |      |             |                   |         |            |         |            |        |
| PRIMARY-TO MEASURE SELECTED ELECTROMAGNETIC RADIATION EMITTED OR                              |                   |        |          |          |      |             |                   |         |            |         |            |        |
| REFLECTED   | FROM THE EA       | ARTH   | AND I    | TS A     | TMO  | SPHE        | RE TO             | 08      | TAIN       | ATA     | ON         | l      |
| THE ALBED   | OO OF THE EAR     | ₹TH-A  | TMOSP    | HERE     | SY   | STEN        | 4, WAT            | TER 1   | VAPOR      | DIS     | TRI        | BU-    |
| TIUN, SUF   | REACE OR CLOU     | JD TE  | MPERA    | TURE     | S A  | ND S        | SEASON            | IAL (   | CHANG      | ES O    | F          |        |
| STRATOSPH   | HERIC TEMPERA     | TURE   | S.***    | SECO     | ND A | RY-         | TO PR             | IVO     | DE AB      | SOLU    | TE         |        |
| RADIOMETR   | RIC DATA TO A     | ID I   | IN EVA   | LUAT     | ING  | DAT         | TA OF             | OTH     | ER EX      | PERI    | MEN        | TS.    |
| RADIOMETRIC DATA TO AID IN EVALUATING DATA OF OTHER EXPERIMENTS.  31. PRINCIPLES OF OPERATION |                   |        |          |          |      |             |                   |         |            |         |            |        |
| THE 5 CHA   | NNEL NIMBUS       | MRIF   | R IS S   | IMIL     | AR   | IN F        | PURPOS            | SE TO   | D THE      | EAR     | LIE        | Ŗ      |
| TIROS MRF   | R, BUT USES A     | IN EN  | NTIREL   | Y NE     | W I  | NSTF        | RUMENT            | DE:     | SIGN.      | RAD     | IA-        |        |
| TION ENTE   | RS THE RADIO      | DMETE  | R BY     | REFL     | EC T | ION         | FROM              | A FI    | LAT S      | CANN    | ING        | ;      |
| MIRROR IN   | CLINED AT 45      | 5 DEG  | TO T     | HE O     | PTI  | CAL         | AXIS.             | . A I   | MECHA      | NICA    | L          |        |
| CHOPPER N   | MODULATES THE     | E RAD  | DIATIO   | N AT     | 60   | HZ.         | . THE             | SPE     | CTRAL      | REG     | ION        | IS     |
| ARE SELEC   | TED BY FILTE      | ERS.   | FOR T    | HIS      | MR I | R TH        | HE REG            | SION    | S (IN      | MIC     | RON        | IS)    |
| ARE 6.4-6   | .9 FOR WATER      | ₹ VAP  | OR DI    | STRI     | BUT  | ION         | IN TH             | IE TI   | ROPOS      | PHER    | Ε,         |        |
| 10-11 FOR   | R SURFACE DR      | CLOU   | JD TEM   | PERA     | TUR  | ES,         | 14.5-             | 15.     | 5 FOR      | STR     | ATO        | -      |
| SPHERIC 1   | TEMPERATURES,     | , 20-  | -23 FO   | R AN     | OTH  | IER V       | NATER             | VAP     | OR ME      | ASUR    | EME        | NT,    |
| AND 0.2-4   | .0 FOR ALBE       | OO ME  | EASURE   | MENT     | S.   | EACH        | 1 CHAN            | INEL    | HAS        | A SE    | PAR        | ATE    |
| OPTICAL S   | SYSTEM CONTAI     | INING  | G A FO   | LDED     | TE   | LESC        | OPE W             | HTI     | A 1.       | 7 IN    | .DI        | A-     |
| METER OB.   | JECTIVE AND A     | 1 2.8  | BDEG     | FOV.     | TH   | E RA        | DIATI             | ON :    | IS FO      | CUSE    | <b>D</b> 0 | OTM    |
| A THERMIS   | STOR BOLOMETE     | ER DE  | TECTO    | R. T     | HE   | SCAN        | INI ING           | MIRE    | ROR R      | TAT     | ES         | AT     |
| 8 RPM SCA   | ANNING IN A P     | LANE   | NORM     | AL T     | 0 T  | HE S        | S/C VE            | LOC     | ITY.       | DUR I   | NG         |        |
|   | DLUTION THE M     |        |          |          |      |             |                   |         |            |         |            | IN     |
|   | N. SPACE AGA      |        |          |          |      |             |                   |         |            |         |            |        |
|   | CORDED FOR S      |        |          |          |      |             |                   |         |            |         |            |        |
|   | OUTPUT FOR        |        |          |          |      |             |                   |         |            |         |            |        |
|   | HIS IS CONVE      |        |          |          |      |             |                   |         |            |         |            |        |
|   | OR TRANSMISS      |        |          |          |      |             |                   |         |            |         |            |        |
| 32. PHENOMENA OBSERVED  |                   |        |          |          |      |             |                   |         |            |         |            |        |
| INFRARED  | RADIATION FR      | ROM T  | HE EA    | RTH      | AND  | ATM         | 10 SPHE           | RE      |            |         |            |        |
| 33. MEASUREM  |                   |        |          |          |      |             |                   | ,       |            |         |            |        |
| 185-300   | DEG K FOR 10      | MCRN   | CHAN     | ;185     | -27  | O DE        | GKF               | OR 6    | 5,15       | MCRN    | СН         | ANS    |
| 34. PRECISION   | AND ACCURACY      |        |          |          |      |             |                   |         |            |         |            |        |
| S/N OF BE   | TTER THAN 30      | DB:    | ABSO     | LUTE     | AC   | CURA        | CY OF             | +-      | 7 DEG      | С       |            |        |

| 25 0050==         | D 4 5 4 5 =  |                     |           |                |       |             |              | 1     |             |       |          |         |           |       |          |          | _        |        |             |
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| 35. SPECTRAL      |              |                     | 7 2       |                |       | 11 7 6      | 200          |       | . SPE       | :CTR/ | AL R     | ESOL    | UTION     | 37    |          |          |          | TANT   |             |
| 0.2               | <b>T</b> (   | ַ                   | 23        |                |       | MIC         |              |       |             |       |          |         |           |       | 2        | .0       | М        | SEC    |             |
| 38. FIELD OF V    |              | · <u> </u>          |           |                |       |             |              | WATH  |             |       |          |         |           |       |          |          |          |        |             |
|                   | BY           | 2.8                 |           | DEG            |       |             | LÜ-          | LIM   | В           | (38   | 00       | NM)     | FR        | MO    | 600      | ) NI     | <u> </u> | ALT    |             |
| 40. ANGULAR RES   |              |                     |           |                |       |             |              |       |             |       |          |         |           |       |          |          |          |        | ]           |
| 2.8               | DEG          | 25 1                | NM I      | FROM           | 6     | 0.0         | NM           | ALT   | IT          | UDE   |          |         |           |       |          |          | `        |        |             |
| 42. POINTING ACCU | JRACY 4      | 3. POIN             | TING      | RATE           |       |             |              | LTITU | DE          |       |          | 1       | INCLIN    |       |          |          |          |        |             |
|                   |              |                     |           |                |       |             | MED          | C     | IR          | CUL   | ΔR       | SU      | IN-S      | YNC   | H        | B E      | TR       | OGR    | ADE         |
| 46. SPECIAL RE    | QUIREN       | MENTS               |           |                |       | 7 2         |              |       |             |       |          |         |           |       |          |          |          |        |             |
|                   |              |                     |           |                |       |             |              |       |             |       |          |         |           |       |          |          |          |        |             |
| 47. COMPONEN      | TS           |                     |           |                |       |             |              |       |             |       |          |         |           |       |          |          |          |        |             |
| RADIOMET          | ER, E        | LEC                 | TRO!      | VICS           |       |             |              |       |             |       |          |         |           |       |          |          |          |        |             |
| 48. WEIGHT        | 49. VOI      | UME                 |           |                | 50.   | AVER.       | AGE PO       | OWER  | 51.         | STAND | BY PO    | WER     | 52. PE    | AK P  | OWE      | R 5      | i3. I    | MTBF   |             |
| 20 LB             |              |                     |           |                |       | 8           |              | TTS   |             |       | WAT      | TS      |           |       |          | $\top$   |          |        |             |
| 54. INTERFERENCE  | 55. MA       | AGNETIC<br>REERENCE | . "       | 56. NU         | CLEAR |             |              | THERM |             |       |          |         | LDING     |       |          |          |          |        |             |
|                   |              |                     |           |                |       |             | _            | ENS   |             |       | 1        |         |           |       |          |          |          |        | $\neg \neg$ |
| 59. CALIBRATIO    | ON           |                     |           |                | Te    | 0. DA       |              | ECOV  |             |       |          |         | 61. FR    | EQUE  | NCY C    | F OBS    | ER       | ATION  |             |
| SPACE AN          | D MR         | R HO                | ous       | ING            | _     |             |              | DT    | _           | _     | TRY      | ,       | CO        | NTI   | NUO      | IUS      |          |        |             |
| 62. TELEMETR      |              |                     |           |                |       |             |              |       |             |       | <u> </u> | -       |           |       |          |          |          |        |             |
| ANALOG S          |              |                     |           | SAMP           | LF    | 0 3         | 3-1          | /3    | TI          | MFS   | PF       | RS      | EC.       | AND   | <u> </u> | NVI      | = R      | TED    | TO          |
| 8-BIT DI          |              |                     |           |                |       |             |              |       |             |       |          |         |           |       |          |          |          |        |             |
| FOR PLAY          |              |                     | •         |                | • •   | , ,         | ••           |       |             | - '   |          | - / 11. |           | 🔾     |          | <i>-</i> |          | . –, , | .           |
| 63. ADVANTAG      |              |                     | ATIO      | vs             |       | · · · · · · |              |       |             |       |          |         |           |       | -        |          |          |        |             |
| IMPROVED          |              |                     |           |                | NS    | FΔ          | ND           | IN-   | FI          | I CH  | Tr       | ΔΙΤ     | BRAT      | r t n | N L      | 2 4      | ī        | N _    |             |
| CREASED           |              |                     |           |                |       |             |              |       |             |       |          |         |           |       |          |          | 1        | · ¶ —  |             |
| 64. REFERENCE     |              |                     | <u> </u>  | A !            |       | ¥ t.        | •            | 110   | <u> </u>    | 11/1  | · •      | , 1 U V | 1 1472    | r 4   | n. 13    | •        |          |        |             |
| 1)GOLDBE          |              | 1 4                 | • M s     | ETEC           | DO    | 100         | v t          | MCT   | DIII        | MEN   | TC       | 500     | CAI       |       |          |          |          | 00 E   |             |
| SENTED A          |              |                     |           |                |       |             |              |       |             |       |          |         |           |       |          |          |          |        |             |
| 23, 1968          |              |                     |           |                |       |             |              |       |             |       |          |         |           |       |          |          |          |        |             |
|                   |              |                     |           |                |       |             |              |       |             |       |          |         |           |       |          |          |          |        |             |
| ***3) NII         | DATA<br>DATA | د. US<br>۱۱۳۱       | ) E. P. ' | 3 U<br>7 A T 1 | OVI   | ים ש        | (1)<br>  (1) | T C 9 | J(<br>1 T 1 | JL T  | 7 Y      | .00     | ~ * * * * | +12   | ADA      | 117      | N I      | , K.   | K•          |
| 4. MARCH          |              |                     |           | . A I I        | UN    | ۳۱.         | HIV.         | AL    | LI          | י ט   | K E 3    | • 4     | 2200      | • •   | IEU      | rı h     | E        | רו וי  | 4U•         |
| 65. HISTORICA     |              |                     |           |                |       |             |              |       |             |       |          |         |           |       |          |          |          |        |             |
|                   |              |                     | ·         | רת ר           | AD    |             | D <b>T</b>   | TOO   | ٠ .         | 400   |          |         |           |       |          |          |          |        | $\dashv$    |
| SIMILAR           | IN PU        | 757US               | ו די      | iu t           | AK    | LIE         | K I          | TKU   | <u> </u>    | 1 K K |          |         |           |       |          |          |          |        | <b></b> -   |
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| 1                 |              |                     |           |                |       |             |              |       |             |       |          |         |           |       |          |          |          |        |             |
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| GREENBELT, MD. 20771   |                          |           |             |                                       |       |            |                   |          |                   |               |              |               |
|--|--------------------------|-----------|-------------|---------------------------------------|-------|------------|-------------------|----------|-------------------|---------------|--------------|---------------|
| 1. TITLE   |                          |           |             |                                       |       |            |                   |          | 2.                | ACRONYM       | 3.           | EXP NO        |
| MEDIUM-RE  | SOLUTION RAD             | MO IC     | ETER        |                                       |       |            |                   |          | M                 | ₹R            |              |               |
| (TITLE CONT.   | )                        |           |             |                                       |       |            |                   |          | 1                 | RESUME DATE   |              | 5.<br>VERSION |
|  |                          |           |             |                                       |       |            |                   | ·        |                   | 9/01/         | 72]          | 0005          |
| 6. PRINCIPAL II  | NVESTIGATOR              |           | GANIZATIO   |                                       |       |            |                   |          | LEPHO             |               |              |               |
| NORDBERG   | , DR. W.                 |           | DARD SP     |                                       | FLT   | CE         | NTER              |          |                   | 2-5042        | <u> </u>     |               |
| 9. CO-INVESTIG   | ATOR                     | 10. OR    | GANIZATIO   | N                                     |       |            |                   | 11. TI   | ELEPHO            | ONE           |              |               |
|  |                          |           | <del></del> |                                       |       |            | 15 67457          |          | 3000 CT100        | T             |              |               |
| 12. CONTRACT<br>TYPE   | 13. CONTRACT NUMB        | ER        | 14. FLASH   | INDEX                                 | NUME  | BER        | 15. START<br>DATE | 16. 5    | OMPLETION<br>DATE | +             |              |               |
|  |                          | T         |             |                                       |       | 1          |                   |          |                   | POST          | FL           | IGHT          |
| 18. MONITOR  |                          | 19. AG    |             |                                       |       | <u> </u>   | OFFICE            |          | ELEPH             |               |              |               |
| TEPPER, M. NASA HDQTRS DA/ERD 202-755-2322 22 VENDOR 23 LOCATION 24 SAST 25 LEAD TIME  |                          |           |             |                                       |       |            |                   |          |                   | 71005         |              |               |
| DATE DATE  |                          |           |             |                                       |       |            |                   |          | TIME              |               |              |               |
| BARNES ENGINEERING CO STAMFORD, CONN. 11/60 NA   |                          |           |             |                                       |       |            |                   |          |                   |               |              |               |
| 20. INSTRUMENT TYPE SECURITY   |                          |           |             |                                       |       |            |                   |          |                   |               |              |               |
| RADIOMETER, 5-CHAN THERMISTOR-BOLOMETER MED-RES SCANNING IR UNC 28. APPLICATION 29. SPACECRAFT                                     |                          |           |             |                                       |       |            |                   |          |                   |               |              |               |
| MET TIRDS 2  |                          |           |             |                                       |       |            |                   |          | <del></del>       |               |              |               |
|  |                          |           |             |                                       |       |            | INUS              | <u> </u> |                   |               |              |               |
| 30. PURPOSE  | TO MEASURE EN            | A I T T I | EN THER     | MAI                                   | V VID | DE         | ELEC.             | TED      | SOL               | AR DAT        | ) T A        | TION          |
| 1  | · - · - · <del>-</del> · | -         | TMOSPHE     |                                       |       |            |                   |          |                   |               |              |               |
| '  | BE STUDIED A             |           |             |                                       |       |            |                   |          |                   |               |              | API-          |
|  |                          |           |             |                                       |       |            |                   |          |                   |               |              | TON           |
| BAND, DAY-NIGHT TIME CLOUD COVER, ALBEDO, AND THERMAL RADIATION.<br>To generate radiation maps for research in atmospheric proper- |                          |           |             |                                       |       |            |                   |          |                   |               |              |               |
| TIES.  | ALE MADIALIO             | A 1.3 M.  | 3 108       | NEJE                                  | ANG   | , !        | 14 ~ 11           | 1031     | HER               | ic inc        | <i>)</i> F L | . ' `         |
|  | OF OPERATION             |           |             |                                       |       |            |                   |          | <u></u>           |               |              |               |
|  | 3,4,7, AND N             | IMBU      | S 2 CON     | TAIN                                  | FD    | 5 0        | HANNE             | -1 5     | CANI              | VING F        | ₹ΔΓ          | T OM-         |
| 1  | ING FILTERS              |           |             |                                       |       |            |                   |          |                   |               |              |               |
| OMETER.  |                          |           |             |                                       |       |            |                   |          |                   |               |              |               |
| ON THE T   | IROS SERIES              |           |             | -                                     |       |            |                   |          |                   |               |              |               |
| FOR TIRO   |                          |           | 72-7.0;     |                                       |       |            |                   |          |                   | 7.2-32        | 2 . 6        | · <b>;</b>    |
| AND 0.36   | 5-3.35 MICRO             |           | A REFER     |                                       |       | VEL        |                   | 081      | ΓΑΙΝΙ             | ED BY         | НΑ           | VING          |
| THE DETER  | CTORS ALTERNA            | ATEL      | Y LOOK      | INTO                                  | SP    | AC E       | AT A              | 4 45     | DE                | GREE A        | NO           | LE.           |
| EACH CHAI  | WHEL HAS THE             | SAM       | E PRINC     | IPLE                                  | OF    | - OP       | ERAT              | ON:      | TH                | E ALTE        | RN           | AT-           |
| ING VOLTA  | AGE GENERATE             | TAC       | THE TH      | ERMI                                  | STO   | R B        | OLOME             | TER      | R IS              | PROP          | ORT          | ION-          |
| AL TO THE  | E DIFFERENCE             | IN        | RADIATI     | ON E                                  | NER   | GY         | COMI              | NG F     | ROM               | 2 OP          | 209          | ITE           |
| DIRECTION  | NS (THROUGH T            | THE :     | SATELLI     | TE W                                  | IALL  | . AN       | D BA              | SE)      | AND               | IMPI          | <b>NGE</b>   | NT            |
| UPON A CI  | HOPPER DISK 1            | THAT      | HAS AL      | TERN                                  | ATE   | BL         | ACK /             | AND.     | MIR               | RORED         |              |               |
| HALVES.  | ALL 5 DISKS F            | ROTA      | TE SIMU     | ILTAN                                 | EOL   | JSLY       | ' AT 4            | 46 F     | RPS.              | AND H         | <b>IAV</b>   | 'E            |
|  | L OUTPUT CIR(            |           |             |                                       |       |            |                   |          |                   |               |              |               |
|  | E SPIN IS USI            |           |             |                                       |       |            |                   |          |                   |               |              |               |
|  | BY ORBITAL N             |           |             |                                       |       |            |                   |          |                   |               |              |               |
| 3  | FOV FOR EACH             |           |             |                                       |       |            |                   |          |                   |               |              |               |
| LITE'S E   | NDLESS LOOP (            | OF M      | AGNETIC     | TAP                                   | EF    | OR         | A PER             | RIOC     | OF                | 100           | 111          | •             |
|  |                          |           |             |                                       |       |            |                   |          |                   |               |              |               |
| 32. PHENOMENA OBSERVED   |                          |           |             |                                       |       |            |                   |          |                   |               |              |               |
|  |                          | 4 1 1 2   | ATHOCO      | UCAC                                  |       |            | CD C C 3          |          | D. C.             | 21022         |              |               |
|  | N FROM EARTH             | AND       | AIMUSP      | HERE                                  | IN    | <u>ל ו</u> | 24FC              | IKAL     | _ KF(             | <u> 1 UNS</u> |              |               |
| 33. MEASUREM   | ENI NANGE                | •         |             | · · · · · · · · · · · · · · · · · · · |       |            |                   |          |                   |               |              |               |
| 34 PRECISION   | AND ACCURACY             |           |             |                                       |       |            |                   |          |                   |               |              |               |
|  | TIO OF BETTER            | ) T.L.    | VVI 30 D    | D • A                                 | D C C | 11 117     | E AC              | 110 4    | (C V )            | )E 4-         | 7 0          | EC V          |
| M J/N KA   | FEO OF DEFIEL            | <u> </u>  | AIN DU L    | <u>ио 🧸 А</u>                         | 031   | <u> </u>   | C AU              | <u> </u> | 40 T I            | JF <b>*=</b>  | , L          | CU K          |

| 35. SPECTRAL RANGE                    | 36. SPECTRAL RESOLUTION 37. TIME CONSTANT                   |
|---------------------------------------|---|
| 0.25 TO 32.6                          |   |
| 38. FIELD OF VIEW                     | 39. GROUND SWATH  |
|                                       | G 35 NMDIAM CIRCLE FROM 410 NM ALTITUDE                     |
| 40. ANGULAR RESOLUTION 41. SPATIAL R  |   |
| . 5.0 DEG B5 NM AT                    | CENTER FROM 410 NM ALTITUDE                                 |
| 42. POINTING ACCURACY 43. POINTING RA |   |
|                                       | MED CIRCULAR MEDIUM POSIGRADE                               |
| 46. SPECIAL REQUIREMENTS              |   |
|                                       |   |
| 47. COMPONENTS                        |   |
| RADIDMETER (5 THERMIS                 | TOR BOLOMETER DETECTORS) - ELECTRONICS                      |
| 48. WEIGHT 49. VOLUME                 | 50. AVERAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF |
| 6 LB                                  | 3 WATTS   |
| 54. INTERFERENCE 55. MAGNETIC 56.     | NUCLEAR ST. THERMAL INTERFERENCE 58. SHIELDING              |
|                                       | SENSITIVE   |
| 59. CALIBRATION                       | 60. DATA RECOVERY 61. FREQUENCY OF OBSERVATION              |
| SPACE LOOK FOR ZEROIN                 | G DELAYED TELEMETRY CONTINUOUS                              |
| 62. TELEMETRY REQUIREMENTS            |   |
| 7 FREQUENCY BANDS ARE                 | USED FOR TOTAL IR PACKAGE (LOW + MED' IR);                  |
| THE 7 CHANNELS HAVE A                 | · · ·   |
|                                       |   |
| 63. ADVANTAGES AND LIMITATIONS        |   |
| AN UNCERTAINTY EXISTS                 | IN THE ABSOLUTE VALUES OF THE MEASUREMENTS                  |
| BECAUSE OF NO INFLIGH                 |   |
| 64. REFERENCES                        | , OALIDAATION   |
| · · · · · · · · · · · · · · · · · · · | .: INFRARED AND REFLECTED SOLAR RADIATION                   |
| •                                     | OS 2 MET SAT. NASA TN D-1096, NOV. 1961.***                 |
| l .                                   | T AND ROCKET EXPTS. NASA/GSFC-NATIONAL                      |
|                                       | R. REPT. NSSDC 68-01, JAN. 68. ***3)                        |
|                                       | NSTRUMENTS FOR SAT. NASA/GSFC, AUG. 68. ***                 |
|                                       | ATIONAL SPACE SCIENCE DATA CTR. NASA/GSFC.                  |
| 65. HISTORICAL REMARKS                | ATTUNAL SPACE SCIENCE DATA CIR. NASA/GSPC.                  |
|                                       | LOWN ON TIROS 2,3,4,7 AND NIMBUS 2 (MRIR)                   |
| SIMILAR FADIUMETERS F                 | LUMN UN TIRUS 2,3,4,7 AND NIMBUS 2 (MKIK)                   |
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| 1. TITLE  |                   |            | ·                  |                    |                   |                   | 2                 | ACRONYM            | 3.             | EXP NO          |  |  |
|---|-------------------|------------|--------------------|--------------------|-------------------|-------------------|-------------------|--------------------|----------------|-----------------|--|--|
| MEDIUM-R  | ESOLUTION RA      | DIOM       | ETER               |                    |                   |                   | M                 | 3 R                |                |                 |  |  |
| (TITLE CONT.                                    | }                 |            |                    |                    |                   |                   | 4. A              | ESUME DATE         |                | 5.<br>VERSION   |  |  |
|   |                   |            | <u>.</u>           |                    |                   |                   | 0.0               | 9/01/              | 72             | 2005            |  |  |
| 6. PRINCIPAL II                                 | NVESTIGATOR       | 7. OR      | GANIZATION         | ATION 8. TELEPHONE |                   |                   |                   |                    |                |                 |  |  |
| NORDBERG, DR. W. GODDARD SPACE FLT CENTER 301-9 |                   |            |                    |                    |                   |                   |                   |                    | 982-5042       |                 |  |  |
| 9. CO-INVESTIGATOR 10. ORGANIZATION 1           |                   |            |                    |                    |                   |                   |                   | ONE                |                |                 |  |  |
|   |                   |            |                    |                    |                   |                   |                   |                    |                |                 |  |  |
| 12. CONTRACT<br>TYPE                            | 13. CONTRACT NUMB | ER         | 14. FLASH INDEX NU | MBER               | 15. START<br>DATE | 16. <sup>Ct</sup> | OMPLETION<br>DATE | 17. STA            | rus            |                 |  |  |
|   |                   |            |                    |                    |                   |                   |                   | POST               | FL             | IGHT            |  |  |
| 18. MONITOR                                     |                   | 19. AG     | ENCY               | 20. PG             | M OFFICE          | 21. T             | ELEPH             | ONE                |                |                 |  |  |
| TEPPER,   | M.                | NAS        | A HDQTPS           | OA                 | /ERD              | 20                | 2-75              | 5 <del>-</del> 232 | 2              |                 |  |  |
| 22. VENDOR                                      |                   |            | 23. LOCATION       |                    |                   |                   | 24. FLIGH<br>DATE | ¹ 25. L            | EAC            | TIME            |  |  |
| BARNES E  | NGINEERING CO     | ) <b>.</b> | STAMFORD, CO       | NNC.               |                   |                   | 7/6               | 61                 |                |                 |  |  |
| 26. INSTRUMEN                                   | IT TYPE .         |            |                    |                    |                   |                   |                   |                    |                | 27.<br>SECURITY |  |  |
| RADIOMET  | ER, 5-CHANNE      | TH         | ERMISTOR-BOLO      | OME 1              | TER ME            | D-RI              | ES <u>S</u> (     | CANNI              | NG             | UNC             |  |  |
| 28. APPLICATIO                                  | N                 |            |                    |                    | 29. SPACE         | CRAF              | T                 |                    |                |                 |  |  |
| MET   |                   |            |                    |                    | TIROS             | 3.                |                   |                    |                |                 |  |  |
| 30. PURPOSE                                     |                   |            |                    |                    |                   |                   |                   |                    |                |                 |  |  |
| DOTILON   | TO MEACHINE E     | ATTT       | ED THEE MALL AN    |                    |                   | TEO               |                   | 4.5 (3.4           | ~ <del>-</del> | 7.01            |  |  |

PPIMARY-TO MEASURE EMITTED THERMAL AND REFLECTED SOLAR RADIATION FROM THE EARTH AND ITS ATMOSPHERE IN 5 SPECTRAL PEGIONS. PARAMETERS TO BE STUDIED ARE: ATMOSPHERIC WATER VAPOR ABSORPTION BAND, DAY-NIGHT TIME CLOUD COVER, ALBEDO, AND THERMAL PADIATION. TO GENERATE RADIATION MAPS FOR RESEARCH IN ATMOSPHERIC PROPERTIES.

### 31. PRINCIPLES OF OPERATION

TIROS 2,3,4,7, AND NIMBUS 2 CONTAINED 5-CHANNEL SCANNING PADIOM-ETERS USING FILTERS AND BOLOMETER DETECTORS. THE NIMBUS 2 PADI-OMETER, WHILE SIMILAR IN PURPOSE, WAS A NEW INSTRUMENT DESIGN. ON THE TIROS SEKIES PRECISE BANDWIDTHS VARIED FOR EACH FLIGHT, FOR TIROS 3 THEY WERE: 5.7-7.0; 7.07-25.0; 0.25-6.82; 7.4-32.6; AND 0.475-2.900 MICRONS. A REFERENCE LEVEL WAS OBTAINED BY HAVING THE DETECTORS ALTERNATELY LOOK INTO SPACE AT A 45 DEGREE ANGLE. EACH CHANNEL HAS THE SAME PPINCIPLE OF OPERATION: THE ALTERNATING VOLTAGE CENERATED AT THE THERMISTOR BOLOMETER IS PROPORTIONAL TO THE DIFFERENCE IN RADIATION ENERGY COMING FROM 2 OPPOSITE DIRECTIONS (THROUGH THE SATELLITE WALL AND BASE) AND IMPINGENT UPON A CHOPPER DISK THAT HAS ALTERNATE BLACK AND MIRRORED HALVES. ALL 5 DISKS ROTATE SIMULTANEOUSLY AT 46 RPS. AND HAVE IDENTICAL OUTPUT CIRCUITRY TO PREAMPLIFIERS AND TAPE RECORDERS. SATELLITE SPIN IS USED TO PROVIDE THE SCAN LINE. WHICH IS THEN ADVANCED BY ORBITAL MOTION OF THE SATELLITE. THE INSTRUMENT HAS A 5 DEG FOV FOR EACH CHANNEL. DATA ARE RECORDED ON THE SATELLITE'S ENDLESS LOOP OF MAGNETIC TAPE FOR A PERIOD OF 100 MIN.

# 32. PHENOMENA OBSERVED

RADIATION FROM EARTH AND ATMOSPHERE IN 5 SPECTRAL REGIONS

## 33. MEASUREMENT RANGE

#### 34. PRECISION AND ACCURACY

A S/N RATIO OF BETTER THAN 30 DB;ABSOLUTE ACCURACY OF +-7 DEG K

| 35. SPECTRAL           | RANG   | E       |           |         |   |            |            |         |            |       |        |         | TION                                    | 37. TIM   | IE C  | ONST     | ANT        |
|------------------------|--------|---------|-----------|---------|---|------------|------------|---------|------------|-------|--------|---------|---|-----------|-------|----------|------------|
| 0.2                    |        | TO      | 3         | 2.6     |   | ΜI         | CRO        | NS      | SEE        | IT    | EM     | 31      |   |           |       |          |            |
| 38. FIELD OF V         | 'IEW   |         |           |         |   |            |            | SWATI   |            |       |        |         |   |           |       |          |            |
| 5.0                    |        |         |           | DE      | G 41  | 0 N        | M D        | IAM     | CI         | RCL   | E F    | ROY     | 47                                      | 5 NM /    | A L   | $\Pi$    | <b>JDE</b> |
| 40. ANGULAR RES        | OLUTIO | N 41.   | SPATI.    | AL RE   | SOLU  | TION       |            |         |            |       |        |         |   |           |       |          |            |
| 5.0                    | DE     | G 40    | NM (      | ΔT      | CE  | NTE        | RF         | ROM     | 47         | 5 N   | M A    | LTI     | TUD                                     |           |       |          |            |
| 42. POINTING ACC       | URACY  | 43. PC  | NITAIC    | IG RA   | TE  |            | 44.        | ALTITU  | JDE        |       |        | 45.1    | NCLIN                                   | ATION     |       |          |            |
|                        |        |         |           |         |   | ****       | ME         | D       | CIR        | CUL   | AR     | ME      | DIU                                     | 4         | P     | OSIO     | GRADE      |
| 46. SPECIAL RE         | EQUIR  | EMEN.   | TS        |         |   |            |            |         |            | v     |        | ·       |   |           |       |          |            |
|                        |        |         |           |         |   |            |            |         | -          |       |        |         |   |           | _     |          |            |
| 47. COMPONEN           | ITS    |         |           |         |   |            |            |         |            |       |        | ·       | 1                                       | ·         |       | 0 100 7  | <u> </u>   |
| RADIOMET               | ER     | (5 1    | HER       | MIS     | TOR   | 80         | LOM        | ETE     | R D        | ETE   | CTO    | RS)     | -                                       | ELECT     | रण    | NIC:     | 5          |
| 48. WEIGHT             | 49. V  | OLUM    | E         |         | 50  | D. AVE     | RAGE       | POWER   | 51.        | STAND | BY POV | VER     | 52. PE                                  | AK POWE   | R     | 53. M    | TBF        |
| 6 LB                   |        |         |           |         |   |            | 3 W        | ATT     | sl         |       |        |         | -                                       |           |       |          |            |
| 54. INTERFERENCE       | 55.    | MAGNET  | IC<br>NCF | 56.     | NUCLEA  | R          | 5          | 7. THEF | RMAL       |       | 58. S  | HIEL    | DING                                    |           |       |          |            |
| 100 1000 000 1100 1100 |        |         |           |         |   |            |            | SEN     |            | IVE   |        | -       | *************************************** |           |       |          |            |
| 59. CALIBRATI          | ON     |         |           |         | I   | 60. D      | ATA        | RECO    |            |       |        |         | 61. FR                                  | EQUENCY C | OF O  | BSERVA   | ATION      |
| SPACE LO               | OK     | FOR     | ZER       | OIN     |   |            |            | ED      |            |       | TRY    |         | cor                                     | TINU      | 3 U   | S        |            |
| 62. TELEMETR           |        |         |           |         | L   |            |            | -       |            |       |        |         |   | - 7       |       |          |            |
| 7 FREQUE               |        |         |           |         | US  | ED         | FOR        | TO      | TAL        | IR    | РΑ     | CKA     | GE :                                    | LOW 4     | +     | MED      | IR);       |
| THE 7 CH               |        |         |           |         |   |            |            |         |            |       |        | •       | -                                       |           |       |          |            |
| 1116 1 011             |        |         | 11-4      | L ~     |   | <i>.</i>   | 0.         |         | •          | _ •   |        |         |   |           |       |          |            |
| 63. ADVANTAG           | SES AN | JD LIM  | HTATI     | ONS     |   |            |            |         |            |       |        |         |   |           |       |          |            |
| AN UNCER               |        |         |           |         | TAL   | TU         | <b>E</b> A | B S D   | LIT        | E V   | ALII   | EĊ      | OF .                                    | THE MO    | Ε Λ   | CHDS     | MENT       |
| BECAUSE                |        |         |           |         |   |            |            |         |            | L V:  | ALU    | LJ      | U1                                      | 1116 (3)  | _ ~   | 3000     |            |
| 64. REFERENC           |        | 1 (197) | LINEL     | Į (j ri | 1 0   | 4L 1       | DNA        | 110     |            |       |        |         |   |           |       |          |            |
| 1)TIROS                |        | ADT     | ATIO      | N D     | ATA   | C A        | TAI        | 00      | AND        | 110   | C 0 1  | СМ      | A MILL                                  | AL CS     | = ^   | <u> </u> | -C 43      |
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| ***2)DAT               |        |         |           |         | -   |            |            |         |            |       |        |         |   |           |       |          | -          |
| 68.NASA/               |        |         |           |         |   |            |            |         |            |       |        |         |   |           |       |          |            |
| METEOROL               |        |         |           |         |   |            |            |         |            |       |        |         |   |           |       |          |            |
| AUG. 196               |        |         |           |         | _   | AIL        | ABL        | E F     | KUM        | NΑ    | 110    | NAL     | 2h                                      | ace St    | ا 1 ر | ENU      | =          |
| DATA CEN               |        |         |           | GSF     | <u>C •                                     </u> |            |            |         |            |       |        |         |   |           |       |          |            |
| 65. HISTORICA          |        |         |           |         |   |            |            |         |            |       |        | • • • • |   |           |       |          |            |
| SIMILAR                | RAD    | IOME    | TER       | S F     | L OM:   | <u>N</u> 0 | N T        | IRU     | <u>S</u> 2 | , 3,  | 4,7    | AV      | U N                                     | IMBUS     |       | (M       | RIR)       |
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| GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771                  |                       |   |            |             |          |        |                  |        |                     |        |            |                                       |
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| 1, TITLE  |                       |   |            | ,           |          |        |                  |        | 2. ACR              | MYM    | 3. E       | XP NO                                 |
|   | SOLUTION RAD          | TOME  | TER        |             |          |        |                  |        | MRR                 |        |            |                                       |
| (TITLE CONT.  |                       | , <u>, , , , , , , , , , , , , , , , , , </u> | - 1 - 17   |             |          |        |                  |        | 4. RESUM            | E DATE | Ţ          | 5.<br>VERSION                         |
| THILE COM.  | <i>*</i>              |   |            |             |          |        |                  |        | 09/0                |        | 2          | 0005                                  |
| 6. PRINCIPAL IN   | NVESTIGATOR           | 7. OR   | GANIZATI   | ON          |          |        |                  | 8. TE  | LEPHONE             | 1/1    | <u>- L</u> | <i>.,</i>                             |
| NORDBERG  |                       | GODI  | DARD S     | PACE        | FLI      | CF     | ENTER            | 301    | -982-5              | 042    |            |                                       |
| 9. CO-INVESTIG  |                       |   | GANIZATI   |             | 7 4 1    |        |                  |        | LEPHONE             |        |            |                                       |
| 0.00  |                       |   |            |             |          |        |                  |        |                     |        |            |                                       |
| 12. CONTRACT<br>TYPE  | 13. CONTRACT NUME     | ER  | 14. FLASI  | 1 INDEX     | ( NUM    | BER    | 15 START<br>DATE | 16. CO | MPLETION 17.        | STAT   | ับร        |                                       |
|   |                       |   | POST FLIGH |             |          |        |                  |        |                     |        |            | IGHT                                  |
| 18. MONITOR   |                       | 19. AG  | ENCY       |             | 2        | O. PGM | OFFICE           | 21. TI | ELEPHONE            |        |            |                                       |
| TEPPER, N   | ۸.                    | NAS   | A HDQT     | RS          | <u> </u> | )A/    | ERD              | 202    | <del>- 755-</del> 2 | 322    |            |                                       |
| 22. VENDOR  |                       |   | 23. LOCA   | TION        |          |        | -                |        | 24. FLIGHT<br>DATE  | 25. L  | EAD        | TIME                                  |
| BARNES EN   | GINEERING CO          | ).  | STAME      | ORD,        | 0.01     | IN.    |                  |        | 2/62                |        |            |                                       |
| 26. INSTRUMEN   | <del></del>           |   |            |             |          |        |                  |        |                     |        |            | 27.<br>SECURITY                       |
| RADIOMETER, 5-CHANNEL THERMISTOR-BOLOMETER MED-RES SCANNING UNC   |                       |   |            |             |          |        |                  |        |                     |        |            |                                       |
| 28. APPLICATION 29. SPACECRAFT                                    |                       |   |            |             |          |        |                  |        |                     |        |            |                                       |
| MET TIROS 4   |                       |   |            |             |          |        |                  |        |                     |        |            |                                       |
| 30. PURPOSE   |                       |   |            |             |          |        |                  |        |                     |        |            |                                       |
|   | TO MEASURE EM         | AITTI   | ED THE     | RMAL        | AN       | R      | EFLEC            | TED    | SOLAR               | RAD    | AIG        | TION                                  |
| 1   | EARTH AND I           |   |            |             |          |        |                  |        |                     |        |            |                                       |
| ETERS TO BE STUDIED ARE: ATMOSPHERIC WATER VAPOR ABSORPTION BAND, |                       |   |            |             |          |        |                  |        |                     |        |            |                                       |
| DAY-NIGHTTIME CLOUD COVER, ALBEDO, AND THERMAL RADIATION.         |                       |   |            |             |          |        |                  |        |                     |        |            |                                       |
| TO GENERATE RADIATION MAPS FOR RESEARCH IN ATMOSPHERIC PROPER-    |                       |   |            |             |          |        |                  |        |                     |        |            |                                       |
| TIES.   | and the second second |   |            |             |          | - '    |                  | _ • .  |                     |        | _          |                                       |
|   | OF OPERATION          |   |            |             |          |        |                  |        |                     |        |            | · · · · · · · · · · · · · · · · · · · |
| TIROS 2.3   | 3,4,7, AND N          | IMBU!   | S 2 CO     | NTAI        | NED      | 5      | CHANN            | EL S   | CANNII              | NG F   | AD         | -MOI                                  |
|   | ING FILTERS           |   |            |             |          |        |                  |        |                     |        |            |                                       |
| 1   | HILE SIMILA           |   |            |             |          |        |                  |        |                     |        |            |                                       |
|   | S SERIES PRE          |   |            | -           |          |        |                  |        |                     |        |            |                                       |
|   | THEY WERE: 6.         |   |            |             |          |        |                  |        |                     |        |            |                                       |
|   | 5 MICRONS.A           |   |            |             |          |        |                  |        |                     |        |            |                                       |
|   | CTORS ALTERNA         |   |            |             |          |        |                  |        | DEGRI               |        |            |                                       |
| l li  | HAS THE SAME          |   |            |             |          |        |                  |        | ALTERI              |        |            |                                       |
| 1   | GENERATED AT          |   |            |             |          |        |                  |        |                     |        |            | L TO                                  |
|   | ERENCE IN RAI         |   |            |             |          |        |                  |        |                     |        |            |                                       |
|   | HROUGH THE S          |   |            |             |          |        |                  |        |                     |        |            |                                       |
|   | DISK THAT HA          |   |            |             |          |        |                  |        |                     |        |            |                                       |
|   | TATE SIMULTA          |   |            |             |          |        |                  |        |                     |        |            |                                       |
|   | Y TO PREAMPL          |   |            |             |          | •      |                  |        |                     |        |            |                                       |
|   |                       |   |            |             |          |        |                  |        |                     |        |            |                                       |
|   | PROVIDE THE :         |   |            |             |          |        |                  |        |                     |        |            |                                       |
|   | F THE SATELL          |   |            |             |          |        |                  |        |                     |        |            |                                       |
|   | DATA ARE RE           |   |            |             |          |        | 115.2            | END    | LE33                | LUUF   | , U        | _                                     |
| MAGNETIC  | TAPE FOR A            | PEKI  | 00 UF      | 100         | MIN      | •      |                  |        |                     |        |            |                                       |
|   |                       |   |            |             |          |        |                  |        |                     |        |            | •                                     |
| 32. PHENOMEN  | A ORCEDVED            |   |            |             |          |        |                  |        |                     |        |            | <del> </del>                          |
|   |                       | AND   | ATMOC      | DUES        | F T      |        | COCC             | TOAT   | DECT                | ) N: C |            |                                       |
| KAULAI LU   | N FROM EARTH          | AND   | AIMUS      | <b>PHEK</b> | t I      | C V    | 24FC             | IKAL   | <u>KEGI</u>         | JM2    |            |                                       |

A S/N RATIO OF BETTER THAN 30 DB; ABSOLUTE ACCURACY OF +-7 DEG K

33. MEASUREMENT RANGE

34. PRECISION AND ACCURACY

| •   |  |  |                    |             |
|---|--|--|--------------------|-------------|
| 35. SPECTRAL RANGE                        |  | 36. SPECTRAL RESOL   | JTION 37. TIME (   | CONSTANT    |
|   | The state of the s | SEE ITEM 31  |                    |             |
| 38. FIELD OF VIEW                         | 39. GROUND SW  |  |                    |             |
|   | DEG 35 NM DIA  | M CIRCLE FROM  | 1 450 NM AL        | TITUDE      |
| 40. ANGULAR RESOLUTION 41. SPATIAL        |  |  |                    | <u> </u>    |
|   | A+ CENTER FRO  | · · · · · · · · · · · · · · · · · · ·  |                    |             |
| 42. POINTING ACCURACY 43. POINTING        |  |  | INCLINATION        |             |
|   | MED  | CIRCULAR ME  | DIUM P             | OSIGRADE    |
| 46. SPECIAL REQUIREMENTS                  |  | A second  |                    |             |
| AZ COMPONICATE                            | THE RESIDENCE OF THE PROPERTY  | Manager Market and the state of |                    | <del></del> |
| 47. COMPONENTS                            | TOTAL BOLOVES  | CD DETECTORS   |                    | NICC        |
| RADIOMETER (5 THERM 48. WEIGHT 49. VOLUME | 131UK BULUMET  | ER DETECTURS   | 52 PEAK POWER      | 53. MTBF    |
|   |  |  | VE. FEAR TOWER     | J3. WI OF   |
| 6 LB                                      | 66. NUCLEAR 57. INT  | I SI THERMAL SB. SHIES   | DING               |             |
| INTERFERENCE INTERFERENCE                 |  | NSITIVE  | -2:110             |             |
| 59. CALIBRATION                           | 60. DATA REG   |  | 61. FREQUENCY OF C | DBSERVATION |
| SPACE LOOK FOR ZERO                       |  | TELEMETRY  | CONTINUOU          |             |
| 62. TELEMETRY REQUIREMENTS                | AND TOLLATED   |  | 1 CONTINUOU        | as week     |
| 7 FREQUENCY BANDS A                       | RE USED FOR 1  | OTAL TR PACK   | GE (LOW +          | MED IR).    |
| THE 7 CHANNELS HAVE                       |  |  | .02 (20%           |             |
| The Committee Have                        |  | · <b>_ </b>  |                    |             |
| 63. ADVANTAGES AND LIMITATION             | NS y   |  |                    | -           |
| AN UNCERTAINTY EXIS                       | TS IN THE ABS  | DLUTE VALUES   | OF THE MEA         | SUREMENTS   |
| BECAUSE OF NO INFLI                       |  |  |                    |             |
| 64. REFERENCES                            | <u>ii.</u>   |  |                    |             |
| 1) TIROS 4 RADIATIO                       | N DATA CATALO  | G AND USER S   | MANUAL. GS         | FC. DEC.    |
| 63.***2) DATA CATAL                       | OG OF SATELLI  | TE AND ROCKET  | EXPTS. NA          | SA/GSFC-    |
| NATIONAL SPACE SCIE                       | NCE DATA CENT  | ER, REPORT NO  | . NSSDC 68         | -01, JAN.   |
| 1968.***3) GOLDBERG                       |  |  |                    |             |
| GSFC, AUG. 68.***4)                       |  |  |                    |             |
| DATA CENTER. NASA/G                       | SFC.   | 4  |                    |             |
| 65. HISTORICAL REMARKS                    |  | The state of the s | k                  |             |
| SIMILAR RADIOMETERS                       | FLOWN ON TIP   | OS 2.3.4.7 A   | ID NIMBUS 2        | (MRIR)      |
|   |  |  |                    |             |
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|   |                   |             | GREENBELT, MD. 2       | 0//1           |  |                                       |       |           |                |               |
|---|-------------------|-------------|------------------------|----------------|--|---------------------------------------|-------|-----------|----------------|---------------|
| 1. TITLE  |                   |             |                        |                | (1) Marie 11 and 12 and 13 and 13 and 13 and 13 and 13 and 13 and 13 and 13 and 13 and 13 and 13 and 13 and 13 |                                       | +     | CRONYM    | 3. E)          | KP NO         |
|   | SOLUTION RAI      | MOIC        | ETER                   |                |  |                                       | MR    | R         |                |               |
| (TITLE CONT.  | )                 |             |                        |                |  |                                       |       | SUME DATE | y<br>V         | ERSION        |
|   |                   | ,           |                        |                |  |                                       |       | /01/7     | <u>' 2   0</u> | 0005          |
| 6. PRINCIPAL IN   |                   |             | GANIZATION             | <del>-</del> - |  | 8. TELE                               |       |           |                |               |
| MCCULLOCK   | <del></del>       |             | DARD SPACE FL          | .T CE          | NTER   |                                       |       | -5042     | <u>,</u><br>   |               |
| 9. CO-INVESTIG  | ATOR              | 10. OR      | GANIZATION             |                |  | 11. TEL                               | PHO   | NE        |                |               |
| 12 CONTRACT   |                   |             | Tag St Agit tags value | 40.            | 15. START<br>DATE  | Le COMPL                              | FTION | 43 CTAT   |                |               |
| 12. CONTRACT<br>TYPE  | 13. CONTRACT NUMB | EH          | 14. FLASH INDEX NUM    | NRFH           | DATE   | 16. COMPL<br>DA                       |       | 17. STAT  |                |               |
| 18. MONITOR   |                   | 19. AG      | ENICY                  | 20. PGM        | OFFICE   | 21. TEL                               |       | POST      | FLI            | . <u>GH I</u> |
| <u> </u>  | 4                 |             |                        |                |  |                                       |       |           | ,              |               |
| 22. VENDOR  |                   |             |                        |                |  |                                       |       |           |                | TIME          |
| BARNES ENGINEERING CO STAMFORD, CONN. 06/63 NA  |                   |             |                        |                |  |                                       |       |           |                |               |
| 2C INCTO MACAIT TYPE  |                   |             |                        |                |  |                                       |       |           |                |               |
| RADIOMETER, 5-CHANNEL THERMISTOR-BOLOMETER MED-RES SCANNING UNC   |                   |             |                        |                |  |                                       |       |           |                |               |
| 28. APPLICATIO  |                   | - , , , , , | ENTITION BOLD          | ,              | 9. SPACE   |                                       | 30    | <u> </u>  | 10             |               |
| MET TIROS 7   |                   |             |                        |                |  |                                       |       |           |                |               |
| 30. PURPOSE   |                   |             |                        |                |  | · · · · · · · · · · · · · · · · · · · |       |           |                |               |
|   | TO MEASURE EN     | TTIP        | ED THERMAL AN          | ID RE          | FLEC   | TED S                                 | OLA   | R RAI     | ΤΔΙ            | ION           |
|   |                   |             | TMOSPHERE IN           |                |  |                                       |       |           |                |               |
|   |                   |             | STRATOSPHERIC          |                |  |                                       |       |           |                |               |
|   |                   |             |                        |                |  |                                       |       |           |                | -             |
| MICRON ABSORPTION BAND OF CO2, DAY-NIGHTTIME CLOUD COVER, ALBEDO, AND THERMAL RADIATION. TO GENERATE RADIATION MAPS FOR |                   |             |                        |                |  |                                       |       |           |                |               |
| RESEARCH IN ATMOSPHERIC PROPERTIES.   |                   |             |                        |                |  |                                       |       |           |                |               |
| 31. PRINCIPLES OF OPERATION   |                   |             |                        |                |  |                                       |       |           |                |               |
| TIROS 2,  | 3,4,7, AND NI     | IMBU:       | S 2 CONTAINED          | 5 (            | HANNE  | EL SC.                                | ANN   | ING P     | ADI            | OM-           |
| ETERS US  | ING FILTERS A     | AND I       | BOLOMETER DET          | ECTO           | DRS.   | THE N                                 | IMB   | US 2      | RAD            | ) I –         |
| OMETER, I   | WHILE SIMILAR     | RIN         | PURPOSE, WAS           | AN             | IEW IN   | NSTRU                                 | MEN   | T DES     | IGN            | ١.            |
| ON THE T  | IROS SERIES F     | PREC        | ISE BANDWIDTH          | IS VA          | ARIED  | FOR                                   | EAC   | H FLI     | GHT            | •             |
| FOR TIROS   | S 7 THEY WERE     | E: 14       | 4.8-15.5; 8.0          | -12            | .c; o.   | 2-6.                                  | 0;    | 8.0-3     | 0.0            | );            |
|   |                   |             | REFERENCE LE           |                |  |                                       |       |           |                |               |
| THE DETE  | CTORS ALTERNA     | ATELY       | Y LOOK INTO S          | PACE           | E AT 4   | 45 DE                                 | GRE   | E ANG     | LE.            | ,             |
| EACH CHAI   | NNEL HAS THE      | SAMI        | E PRINCIPLE O          | F OF           | PERATI   | ION:                                  | THE   | ALTE      | RNA            | T-            |
| ING VOLTA   | AGE GENERATED     | TAC         | THE THERMIST           | OR E           | BOLOME   | ETER                                  | ΙS    | PROPO     | RTI            | ON-           |
|   |                   |             | RADIATION ENE          |                |  |                                       |       |           |                |               |
| DIRECTION   | NS (THROUGH 1     | THE :       | SATELLITE WAL          | L AN           | ND BAS   | SE) A                                 | ND    | IMPIN     | IGEN           | IT -          |
|   |                   |             | HAS ALTERNAT           |                |  |                                       |       |           |                |               |
| HALVES.   | ALL 5 DISKS F     | ROTA        | TE SIMULTANEO          | USLY           | AT 4   | 46 RP                                 | S A   | ND HA     | ١VE            |               |
|   |                   |             | RY TO PREAMPL          |                |  |                                       |       |           |                |               |
| SATELLIT  | E SPIN IS USE     | ED T        | O PROVIDE THE          | SCA            | IN LIM   | VE. W                                 | HIC   | H IS      | THE            | EN            |
|   |                   |             | ON OF THE SAT          |                |  |                                       |       |           |                |               |
| A 5 DEG I   | FOV FOR EACH      | CHA         | NNEL. DATA AR          | E RE           | CORDE  | ED ON                                 | TH    | E SAT     | EL-            | •             |
| LITE'S E  | NDLESS LOOP (     | OF M        | AGNETIC TAPE           | FOR            | A PEF  | RIOD                                  | 0F    | 100 N     | IIN.           | ,             |
|   |                   |             |                        |                |  |                                       |       |           |                |               |
| 32. PHENOMENA OBSERVED  |                   |             |                        |                |  |                                       |       |           |                |               |
|   |                   |             |                        |                |  |                                       |       |           |                |               |
|   |                   | AND         | ATMOSPHERE I           | N 5            | SPECT  | TRAL                                  | REG   | IONS      |                |               |
| 33. MEASUREM  | EN I RANGE        |             |                        |                |  |                                       |       |           |                |               |
| 24 PPECICION  | AND ADDITION      |             |                        | <del></del>    |  |                                       |       |           | <del></del>    |               |
|   | AND ACCURACY      | · ·         | 111 20 00 111          |                |  |                                       |       |           |                |               |
| A SIN KA  | ITO OF RELIER     | < TH/       | AN 30 DB; ABS          | OL U1          | E AC   | JUR AC                                | Y 0   | F +-7     | ′ DE           | GK            |

| · · · · · · · · · · · · · · · · · · ·         |   |
|---|---|
| 35. SPECTRAL RANGE                            | 36. SPECTRAL RESOLUTION 37. TIME CONSTANT                   |
| 0.25 TO 30.0                                  | MICRONS SEE ITEM 31   |
| 38. FIELD OF VIEW                             | 39. GROUND SWATH  |
| 5.0 DEG                                       | 35 NM DIAM CIRCLE FROM 400 NM ALTITUDE                      |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION |   |
| 5.0 DEG 35 NM AT (                            | CENTER FROM 400 NM ALTITUDE                                 |
| 42. POINTING ACCURACY 43. POINTING RATE       |   |
|   | MED CIRCULAR MEDIUM POSIGRADE                               |
| 46. SPECIAL REQUIREMENTS                      |   |
|   |   |
| 47. COMPONENTS                                |   |
|   | OR BOLOMETER DETECTORS) - ELECTRONICS                       |
| 48. WEIGHT 49. VOLUME                         | 50. AVERAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF |
| 6 LB  | 3 WATTS   |
| 54 INTERFERENCE 55 MAGNETIC 56 INTE           | UCLEAR FRENCE 57 INTERFERENCE 58. SHIELDING                 |
|   | SENSITIVE   |
| 59. CALIBRATION                               | 60. DATA RECOVERY 61. FREQUENCY OF OBSERVATION              |
| SPACE LOOK FOR ZEROING                        | DELAYED TELEMETRY   CONTINUOUS                              |
| 62. TELEMETRY REQUIREMENTS                    |   |
|   | JSED FOR TOTAL IR PACKAGE (LOW + MED IR).                   |
| THE 7 CHANNELS HAVE A                         | IIDTH OF 310 HZ.  |
|   |   |
| 63. ADVANTAGES AND LIMITATIONS                |   |
| 1   | IN THE ABSOLUTE VALUES OF THE MEASUREMENTS                  |
| BECAUSE OF NO INFLIGHT                        | CALIBRATION.  |
| 64. REFERENCES                                |   |
|   | A CATALOG AND USER'S MANUAL V.1,GSFC,SEPT                   |
|   | OG OF SATELLITE AND ROCKET EXPTS. NSSDC                     |
|   | C NATIONAL SPACE SCIENCE DATA CTR. ***3)                    |
| · · · · · · · · · · · · · · · · · · ·         | FC NO.X-650-63-99, NASA/GSFC, MAY 63.***                    |
|   | ISTRUMENTS FOR SATELLITES. NASA/GSFC, AUG.                  |
|   | FROM NAT SPACE SCIENCE DATA CTR. GSEC.                      |
| 65. HISTORICAL REMARKS                        | 1   |
| SIMILAR RADIOMETERS FLO                       | OWN ON TIROS 2.3.4.7 AND NIMBUS 2 (MRIR)                    |
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| 1. TITLE             |                   |        |                    |         |                   |       | 2                 | ACRONYM    | 3. E | XP NO           |
|----------------------|-------------------|--------|--------------------|---------|-------------------|-------|-------------------|------------|------|-----------------|
| MICROWAV             | E RADIOMETER.     | /SCA   | TTEROMETER A       | ND A    | LTIME             | TER   | MI                | RSA        | 5-   | 193             |
| (TITLE CONT.         | )                 |        |                    |         |                   |       | 4. FI             | ESUME DATE |      | 5.<br>VERSION   |
| FACILIY:             | EARTH RESOU       | RCES   | EXP. PACKAG        | E (E    | REP)              |       | 0.                | 9/01/      | 72   | 0004            |
| 6. PRINCIPAL IN      | NVESTIGATOR       | 7. OR  | GANIZATION         |         |                   | 8. TI | ELEPHO            | NE         |      |                 |
| EVANS, D             | •                 | MAN    | NED SPACECRA       | FT C    | ENTER             | 71    | 3-48              | 3-012      | 3    | _               |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION         |         |                   | 11. T | ELEPHO            | ONE        |      |                 |
|                      |                   |        |                    |         |                   |       | _                 |            |      |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | MBER    | 15. START<br>DATE | 16. C | OMPLETION<br>DATE | 17. STA    | rus  |                 |
|                      |                   |        |                    |         |                   |       |                   | ENG.       | MOD  | EL              |
| 18. MONITOR          |                   | 19. AG | ENCY               | 20. PGM | OFFICE            | 21. T | TELEPH            | ONE        |      |                 |
| FISCHETT             | I. T.L.           | NAS.   | A HDQTRS           | OA/     | EŔS ,             | 20.   | 2-75              | 5-232      | 2    |                 |
| 22. VENDOR           |                   |        | 23. LOCATION       |         |                   |       | 24 FLIGH<br>DATE  | ¹ 25. L    | EAD  | TIME            |
| GENERAL              | ELECTRIC CO.      |        |                    |         |                   |       | 19                | 73         |      |                 |
| 26. INSTRUMEN        | IT TYPE           |        |                    |         |                   |       |                   |            |      | 27.<br>SECURITY |
| MICROWAV             | E RADIOMETER      | /SCA   | TTEROMETER A       | ND A    | LTIME             | TER   |                   |            |      | UNC             |
| 28. APPLICATIO       | N                 |        |                    | [2      | 9. SPACE          | CRAF  | T                 |            |      |                 |
| ERSP                 |                   |        |                    |         | SKYLA             | B-A   |                   |            |      |                 |
| 30. PURPOSE          |                   |        |                    |         |                   |       |                   |            |      |                 |

PRIMARY-TO PROVIDE SIMULTANEOUS EVALUATIONS OF RADAR BACKSCATTERING CROSS-SECTION AND PASSIVE MICROWAVE EMISSIVITY OF LAND
AND SEA\*\*\*SECONDARY-TO PROVIDE DATA FOR USE IN DESIGNING A RADAR
ALTIMETER FOR SPACE USE\*\*\*TERTIARY-TO OBTAIN INITIAL VALUE DATA
FOR THE ATMOSPHERE ABOVE THE BOUNDARY LAYER TO AID IN NUMERICAL
WEATHER PREDICTION.
31. PRINCIPLES OF OPERATION

THE ACTIVE/PASSIVE MICROWAVE SYSTEM IS A COMBINATION RADAR SCAT-TEROMETER AND PASSIVE MICROWAVE RADIOMETER OPERATING AT 13.9GHZ. THE ALTIMETER OPERATES INDEPENDENTLY. THE EXPERIMENT IS BASED ON SIMULTANEOUS MEASUREMENTS OF RADAR DIFFERENTIAL BACKSCATTER-ING CROSS SECTION AND PASSIVE MICROWAVE EMISSIVITY OF LAND AND SEA SURFACES. THE ANTENNA IS A 4 FOOT MECHANICALLY SCANNING PARABOLIC REFLECTOR WITH A 1.4 DEG HALF-POWER CONICAL PENCIL BEAM. ON THE NON-CONTIGUOUS "ALONG TRACK" AND "CROSS TRACK" SCANNING MODES THE ANTENNA MOVES IN DISCRETE STEPS ( 0. 15. 30. 40, AND 48 DEG ) FROM ONE CELL TO ANOTHER DWELLING ON EACH CELL A PREDETERMINED PERIOD OF TIME. DURING CONTIGUOUS SCAN MODES THE ANTENNA MOVES CONTINUOUSLY EITHER ALONG TRACK (O TO 48 DEG ) OR CROSS-TRACK (+-12.5 DEG CENTERED ON ROLL ANGLES OF +-30. +-15 AND O DEG AT PITCH ANGLES OF O, 15, 30, 40, AND 48 DEG ). THE ALTIMETER, A NARROW PULSE RADAR, TRANSMITS A 100 OR 10 NANO-SECOND PULSE AT A PRR OF 360/SECOND AND A PEAK POWER OF 2 KILO-WATTS. THE RECEIVED SIGNAL IS DOWN-CONVERTED AND SQUARE-LAW DE-TECTED. THE ALTIMETER ALSO PERFORMS IN-PHASE AND QUADRATURE DETECTION.

### 32. PHENOMENA OBSERVED

RADAR DIFFERENTIAL BACKSCATTERING, PASSIVE MICROWAVE EMISSIVITY
33. MEASUREMENT RANGE

KU-BAND

34. PRECISION AND ACCURACY

TRACKER HAS NOISE LEVEL <1-METER RMS AT S/N RATIOS =OR> 20 DB

|   | <u></u>        |  |                                       | <u> </u>     |  |
|---|----------------|--|---------------------------------------|--------------|--|
| 35. SPECTRAL RANGE                            |                | 36. SPECTRAL RE  | SOLUTION                              | 37. TIME CO  | <del>~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~</del> |
| 13.9  | GHZ            | NA   |                                       | 4 • 5        | SEC  |
| 38. FIELD OF VIEW                             | 39. GROUND SWA | ATH  |                                       |              |  |
| SEE ITEM 31                                   | 342 NM         | ,  |                                       | ·            |  |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION |                | 0  |                                       |              |  |
|   | NE AT NADI     |  | 45 12101 121                          | TION         | . i  |
| 42. POINTING ACCURACY 43. POINTING RATI       |                |  | 45. INCLINA                           | <u></u>      |  |
|   | G/SEC 235      | NM   | 50 DEG                                | ·            | <del></del>                                      |
| ANTENNA REQUIRES UNDBS                        | TOUCTED VI     | EU 4-49 DE   | C EDON                                | MADED        |  |
| 47. COMPONENTS                                | INUCTED VI     | CM Y-40 UE   | G FRUM                                | NAUIK.       |  |
| RADIOMETER, SCATTEROME                        | TED. ALTIM     | ETED ANTE  | NAIA EI                               | ECTPONT      | rc   |
| 48. WEIGHT 49. VOLUME                         |                | ER 51. STANDBY PO  |                                       |              | 53. MTBF   |
|   | T 153 WAT      | and the second s |                                       |              |  |
| <u> </u>                                      |                |  | HIELDING                              |              |  |
| SOURC/SEN SENSITIVE                           |                |  |                                       |              |  |
| 59. CALIBRATION                               | 60. DATA REC   | OVERY  | 61. FRE                               | QUENCY OF OB | SERVATION  |
| COLD SKY REFERENCE LOA                        |                | PE/10 KILD   | BITICON                               | TINUOUS      |  |
| 62. TELEMETRY REQUIREMENTS                    |                |  |                                       |              |  |
| NA  |                |  |                                       |              |  |
|   |                |  |                                       |              |  |
|   |                |  |                                       |              |  |
| 63. ADVANTAGES AND LIMITATIONS                |                |  | ,                                     |              | MALTE MIS.                                       |
| CAN OPERATE BOTH DAY A                        | ND NIGHT A     | ND GENERALI  | LY IS N                               | OT AFFE      | CTED BY  |
| CLOUDS AND WEATHER.                           |                | •  |                                       |              |  |
| 64. REFERENCES                                |                | •  | · · · · · · · · · · · · · · · · · · · |              |  |
| 1. EXPERIMENT IMPLEMENT                       |                |  |                                       |              |  |
| MENTS, TITLE: MICROWAVI                       |                |  |                                       |              | •  |
| 2. EARTH RESOURCES REM                        |                |  |                                       |              |  |
| 3. OPPORTUNITIES FOR PA                       |                | · ·  | E FLIGH                               | T INVES      | TIGA-  |
| TIONS, MEMO CHANGE 33,                        | -              |  |                                       | ,            |  |
| 4. SKYLAB-A, EREP USER                        | S HANDBOOK     | NASA MSC   | FEB.1                                 | 971.         |  |
| 65. HISTORICAL REMARKS                        |                |  |                                       | · · · · · ·  |  |
|   |                |  | · · · · · · · · ·                     |              | ······································           |
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### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771

| 1. TITLE             |                   |        | •                  |         |                   |        | 2. A               | CRONYM     | 3. E | XP NO           |
|----------------------|-------------------|--------|--------------------|---------|-------------------|--------|--------------------|------------|------|-----------------|
| MULTI-SP             | ECTRAL SCANN      | ER     | ,                  |         |                   |        | MS                 | SS         |      |                 |
| (TITLE CONT.         | )                 |        |                    |         |                   |        | 4. RI              | ESUME DATE |      | 5.<br>VERSION   |
|                      |                   |        |                    |         |                   |        | 0.5                | 7017       |      | 2004            |
| 6. PRINCIPAL II      | NVESTIGATOR       | 7. OR  | GANIZATION         |         |                   | 8. TE  | LEPHO              | NE         |      |                 |
| ARLAUSKA             | S, J.             | GOD    | DARD SPACE FL      | _T C    | ENTER             | 301    | -982               | 2-5042     | 2    | -               |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION         |         |                   | 11. TE | LEPHO              | NE         |      |                 |
|                      |                   |        |                    |         |                   |        |                    |            |      |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | MBER    | 15. START<br>DATE | 16. CO | MPLETION<br>DATE   | 17. STAT   | ับร  |                 |
| CPFF                 | NAS5-11255        |        |                    |         | 11/69             | 9 8    | 771                | OPERA      | ΔTI  | ONAL            |
| 18. MONITOR          |                   | 19. AG | ENCY               | 20. PGM | OFFICE            | 21. TI | ELEPHO             | ONE        |      |                 |
| SCHARDT,             | В.                | NAS    | A HDQTRS           | DA/     | ERN               | 202    | -755               | -2322      | 2    |                 |
| 22. VENDOR           | -                 |        | 23. LOCATION       |         |                   | ' I    | 24. FLIGHT<br>DATE | 25. L      | EAD  | TIME            |
| HUGHES A             | IRCRAFT CO.       |        | EL SEGUNDO,        | CAL     | IF.               |        | 7/7                | 72 NA      |      |                 |
| 26. INSTRUMEN        | T TYPE            |        |                    |         |                   |        |                    |            |      | 27.<br>SECURITY |
| RADIOMET             | ER,               |        |                    |         |                   |        |                    |            |      | UNC             |
| 28. APPLICATIO       | N                 |        |                    | 2       | 9. SPACE          | CRAFT  |                    |            |      |                 |
| ERSP, AG             | RI, GEOG, GEO     | OL, (  | DCEAN              |         | ERTS-             | -1 &B  |                    |            |      |                 |
| 30. PURPOSE          |                   |        |                    |         |                   |        |                    |            |      |                 |

PRIMARY-TO PROVIDE RADIOMETRIC DATA (FOUR SPECTRAL BANDS ON ERTS-A: 0.5-0.6, 0.6-0.7, 0.7-0.8, 0.8-1.1 MICRONS; A FIFTH BAND ON ERTS-B: 10.4-12.6 MICRONS) ALLOWING IDENTIFICATION, ANALYSIS, AND IMAGERY OF EARTH TARGETS.

### 31. PRINCIPLES OF OPERATION

THE MSS HAS A 2-ELEMENT CASSEGRAIN MIRROR SYSTEM (F/3.6) WITH A 9-IN DIAMETER PRIMARY AND A ROCKING SCAN MIRROR, LOCATED IN THE OBJECT PLANE, WITH CROSS-ORBITAL-TRACK SWEEP RATE OF 13.6 HZ. THE IMAGE IS FOLDED TWICE AND FOCUSED ON A SQUARE FIBER OPTIC INDIVIDUAL FIBERS COUPLE THE FOCUSED OPTICAL ENERGY TO A BAND FILTER AND DETECTOR ASSEMBLY. BANDS 1,2,63 UTILIZE TRI-AXIAL PHOTOMULTIPLIER TUBES WHILE BAND 4 USES SILICON PHOTO-SIX DETECTORS ARE PARALLELED IN EACH OF THE FIRST FOUR BANDS BY A ROW OF FIBER OPTIC BUNDLES STACKED IN THE DIRECTION OF THE ORBITAL TRACK PERMITTING A SLOWER SCANNING MOTION OF THE ROCKING MIRROR SYSTEM. TWO DETECTORS ARE USED IN THE THERMAL THE BASIC MSS SCAN LINE SYNCHRONIZATION IS PROVIDED BY AN OPTICAL PULSE GENERATOR. A MULTIPLEXER IS INCLUDED IN THE MSS AND PROCESSES THE VIDEO DATA. THE 24 (OR 26) CHANNELS OF VIDEO ARE TIME-DIVISION-MULTIPLEXED INTO A SINGLE DATA STREAM OF APPROXIMATELY 2.4 MHZ. THE MULTIPLEXED SIGNAL IS THEN CONVERTED INTO A 15 MB/S PCM SIGNAL BY AN A/D CONVERTER. LINE START. PCM FORMAT INFORMATION, AND CALIBRATION DATA ARE INCLUDED IN THE MULTIPLEXER OUTPUT SIGNAL.

### 32. PHENOMENA OBSERVED

REFLECTED SOLAR AND THERMAL RADIATION FROM THE EARTH

33. MEASUREMENT RANGE

VISIBLE AND NEAR INFRARED RADIATION

34. PRECISION AND ACCURACY

S/N 17-39 DB DEPENDING ON RADIANCE LEVEL AND BAND (FREQUENCY)

| 35. SPECTRAL RANGE                        | 36. SPECTRAL RESOLUTION 37. TIME CONSTANT  |
|---|--|
| 0.5 TO 12.6                               | MICRONS  |
| 38. FIELD OF VIEW                         | 39. GROUND SWATH   |
|   | 100 NM BY 1556 FT FROM 492 NM ALTITUDE.  |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES    |  |
|   | 1556 FT FROM 492 NM ALTITUDE   |
| 42. POINTING ACCURACY 43. POINTING RATI   | the state of the s |
| 46. SPECIAL REQUIREMENTS                  | MED C TRCULAR   SUN-SYNCH RETROGRADE   |
|   | F. 10 TO 30 DEC C  |
| OPERATING THERMAL RANG                    | E · 10 · 10 · 30 · DEG · C   |
|   | ISM, FIBER AND RELAY OPTICS, DETECTORS   |
| 48. WEIGHT 49. VOLUME                     | 50. AVERAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF  |
| 136 LB 6.1 CU F                           | The state of the s |
| 54. INTERFERENCE 56. INTERFERENCE 56. INT | UCLEAR ST. INTERPERENCE 58. SHIELDING  |
|   | SENSITIVE THERMAL SHIELDING  |
| 59. CALIBRATION                           | 60. DATA RECOVERY 61. FREQUENCY OF OBSERVATION.  |
| ROUTINE IN-FLIGHT CALI                    | B. DELAYED AND REALTIME CONTINUOUS   |
| 62. TELEMETRY REQUIREMENTS                |  |
| 60 ANALOG CHANNELS; 39                    | DIGITAL POINTS   |
|   |  |
|   |  |
| 63. ADVANTAGES AND LIMITATIONS            |  |
| FIRST MULTI-SPECTRAL S                    | ATELLITE RADIOMETER  |
| 64. REFERENCES                            |  |
| 1) MULTISPECTRAL SCANNE                   | R SYSTEM FOR ERTS (DOCUMENT OBTAINED FROM  |
|   | CT PLAN FOR EARTH RESOURCES TECHNOLOGY   |
| SATELLITE (ERTS-A/B) C                    |  |
|   |  |
|   |  |
|   |  |
| 65. HISTORICAL REMARKS                    |  |
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### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771

|                      |                                 |        | ,             |        |             |                   |         |           |           | 0.534       | 2 210           |
|----------------------|---------------------------------|--------|---------------|--------|-------------|-------------------|---------|-----------|-----------|-------------|-----------------|
| 1. TITLE             |                                 |        |               |        |             |                   |         |           | CRONYM    | 3. EX       |                 |
| NIMBUS E             | MICROWAVE SI                    | PECT   | ROMETER_      | ,      |             |                   |         |           | MS        | E07         |                 |
| (TITLE CONT.         | )                               |        |               |        |             |                   |         |           | SUME DATE |             | RSION           |
|                      |                                 |        |               |        |             |                   | 8. TEL  |           | 9/01/     | (210        | 009             |
| 6. PRINCIPAL IN      |                                 | -      | GANIZATION    | - +-   | C 1 1 1 1 C | 1 DCV             |         |           |           | 0 - V2      | 711             |
|                      | DR. D.H.                        |        | S INST D      | - 151  | CHNU        | LUGY              | 11. TEI |           | +-690     | <u>U-X3</u> | 771             |
| 9. CO-INVESTIG       |                                 |        | BANIZATION    | TON 1  | 1 4 0       |                   |         |           | +-302     | 6           |                 |
|                      | F. T., ET AL  13. CONTRACT NUMB |        | 14. FLASH INI |        |             | 15. START<br>DATE |         |           | 17. STA   |             |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NOMB               | En     | 14. PLASTI IN | JEX NO | WIDEI       | 01/6              |         | /A.I.     | ENG.      |             |                 |
| 18. MONITOR          |                                 | 19. AG | FNCY          |        | 20. PG      | M OFFICE          | 21. TE  | LEPHO     |           | nuu         |                 |
| SCHARDT,             | R.R.                            |        | A HDQTRS      |        | ΠΔ          | ERN               |         |           | 5-232     | 2           |                 |
| 22. VENDOR           | 0.0.                            | 1117   | 23, LOCATIO   | N      |             | -111              |         | 4. FLIGHT |           | EAD T       | IME             |
|                      | ULSION LAB                      |        | PASADEN       | A. C   | ALIF        | ORNIA             |         | 12/       |           | MON         | THS             |
| 26. INSTRUMEN        |                                 |        |               |        |             |                   |         |           |           |             | 27.<br>SECURITY |
|                      | ER, 5-CHANNE                    | L DI   | CKE SUPE      | RHET   | EROD        | YNE M             | ICRO    | WAV       | E         |             | UNC             |
| 28. APPLICATIO       |                                 |        |               |        |             | 29. SPACE         |         |           |           |             | ·               |
| MET                  |                                 |        |               |        |             | NIMBU             | SE      |           |           |             |                 |
| 30. PURPOSE          |                                 |        |               |        |             |                   |         |           |           |             |                 |
|                      | TO DEMONSTR                     |        |               |        |             |                   |         |           |           |             | - 1             |
|                      | E SENSORS FO                    |        |               |        |             |                   |         |           |           |             | -               |
|                      | ATER VAPOR A                    |        |               |        |             |                   |         |           |           |             | l               |
|                      | Y - TO SUPPL                    |        |               |        |             |                   |         |           |           |             | Į               |
| WEATHER              | PREDICTION P                    | URPO   | SES, ESP      | ECIA   | LLY         | OVER              | cron    | D-C       | OVERE     | D           | ŀ               |
|                      | OF THE EARTH                    | •      |               |        |             |                   |         |           |           |             |                 |
|                      | OF OPERATION                    |        |               |        |             |                   |         |           |           |             |                 |
|                      | RUMENT, VIEWI                   |        |               |        |             |                   |         |           |           |             |                 |
|                      | ATION AT 22.                    | -      |               |        |             |                   |         |           |           |             |                 |
|                      | WATER VAPOR                     |        |               |        |             |                   |         |           |           |             |                 |
|                      | SCRETE LAYER                    |        |               |        |             |                   |         |           |           |             |                 |
|                      | URE PROFILE;                    |        |               |        |             |                   |         |           |           |             |                 |
|                      | WATER VAPOR                     |        |               |        |             |                   |         |           |           |             |                 |
|                      | THESE METEOR                    |        |               |        |             |                   |         |           |           |             |                 |
|                      | HE THREE CHA                    |        |               |        |             |                   |         |           |           |             |                 |
|                      | PERMIT WATER                    |        |               |        |             |                   |         |           |           |             | • • •           |
|                      | BE ESTIMATE                     |        |               |        |             |                   |         |           |           |             | ای              |
|                      | ICE AS SENSI                    |        |               |        |             |                   |         |           |           |             |                 |
|                      | TIMES AS SE                     |        |               |        |             |                   |         |           |           |             | .               |
|                      | POR CHANNELS                    |        |               |        |             |                   |         |           |           |             | RA-             |
|                      | E THE SURFAC                    |        |               |        |             |                   |         |           |           |             |                 |
|                      | DIRECT TEMP                     |        |               |        |             |                   |         |           |           |             |                 |
|                      | SHARE A COMM                    |        |               |        |             |                   |         |           |           |             |                 |
|                      | OTH WATER-VA                    |        |               |        |             |                   |         |           |           |             |                 |
|                      | E ANTENNAS.T                    |        |               |        |             |                   |         |           |           |             |                 |
|                      | ION OF THE S                    |        |               |        |             |                   |         |           |           |             |                 |
| 32. PHENOMEN         |                                 |        |               |        |             |                   |         |           |           |             |                 |
| ATMOSPHE             | RIC AND SURF                    | ACE    | RADIATIO      | N IN   | TH          | E 0.5             | TO 1    | .35       | CM B      | AND         | 2               |
|                      | ACAIT BANCE                     |        |               |        |             |                   |         |           |           |             |                 |

TEMP-2 DEG K; WATER-VAPOR-0.1 GM/SO CM: CLOUDS-0.04 GM/SO CM

RADIANT TEMPERATURE FROM 175 TO 400 DEG KELVIN

34. PRECISION AND ACCURACY

| 35. SPECTRAL RANGE                 |             |              | 36. SPECTRAL RE              | SOLUTION       | 37. TIME CONSTANT     |
|------------------------------------|-------------|--------------|------------------------------|----------------|-----------------------|
|                                    | .35         |              |                              |                |                       |
| 38. FIELD OF VIEW                  |             | GROUND SWA   |                              |                |                       |
| 9.0                                |             |              | AM CIRCLE                    | <u>FRJM 60</u> | O NM ALTITUDE         |
| 40. ANGULAR RESOLUTION 41. SPATIA  | L RESOLUT   | TION         |                              |                |                       |
|                                    |             |              |                              | T              |                       |
| 42. POINTING ACCURACY 43. POINTING | RATE        | 44. ALT      | ITUDE                        | 45. INCLINA    |                       |
|                                    | <del></del> | MED          |                              | I SUN-SY       | NCH HIGH NOON         |
| 46. SPECIAL REQUIREMENTS           |             |              |                              |                | 0.750 CWW W.7511      |
| CALIBRATION REFEREN                | CE ANT      | ENNAS M      | UST HAVE U                   | NOBSIKU        | CLED 2KA ATEM         |
| 47. COMPONENTS                     | T C 111 A C | · /2 CET     |                              | ATED EL        | CCTDONICC             |
| RADIOMETERS (5) AN                 | I ENNAS     | AVERACE POW  | SI ASSULI                    | A I E D E L    | K POWER 53. MTBF      |
|                                    |             |              |                              |                |                       |
| 50 LB 1.33 C                       | 56. NUCLEAR |              | TS NONE HERMAL ERFERENCE 58. | SHIELDING      | WATTSI                |
| SENSITIVE                          | INTERPERE   |              |                              |                | BLZD TO 25+-5C        |
| 59. CALIBRATION                    | 1           | 60. DATA REC |                              | 61. FRE        | QUENCY OF OBSERVATION |
| HOT & COLD REFERENC                | <del></del> |              | TELEMETRY                    |                | TINUOUS               |
| 62. TELEMETRY REQUIREMENTS         |             | <u> </u>     | The Late of the Table        |                |                       |
| 60 BPS                             |             |              |                              |                |                       |
|                                    |             |              |                              |                |                       |
|                                    |             |              |                              |                |                       |
| 63. ADVANTAGES AND LIMITATIO       | NS          |              |                              |                |                       |
| TECHNIQUE IS NOT LI                | MITED       | TO SUN       | ANGLE CONS                   | IDERATI        | ONS OR CLOUD          |
| FORMATIONS.                        |             |              |                              |                |                       |
| 64. REFERENCES                     |             |              |                              |                |                       |
| 1) PROPOSAL FOR MIC                | ROWAVE      | SPECTR       | OMETER, FE                   | B 68.**        | *2) MEEKS, M.L.       |
| AND LILLY, A.E.: J.                | G.R. V      | 7.68, P.     | 1683, (196                   | 3).***3        | ) LENDIR, W.B.:       |
| PHD THESIS MIT, (19                | 651.**      | **4) STA     | ELIN, D.H.                   | : J.G.R        | . V.71 P.2875         |
| (1966).                            |             |              |                              |                |                       |
|                                    |             |              |                              |                |                       |
|                                    |             |              |                              |                |                       |
| 65. HISTORICAL REMARKS             |             |              |                              |                |                       |
| ·                                  |             |              |                              |                |                       |
|                                    |             | •            |                              |                |                       |
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| 1. TITLE             |                   |        |                   |         |                   |       | 2. 4               | CRONY   | м 3   | B. EXI   | P NO          |
|----------------------|-------------------|--------|-------------------|---------|-------------------|-------|--------------------|---------|-------|----------|---------------|
| PRESSURE             | MODULATED C       | 02 R   | ADIOMETER FO      | R UP    | PER               |       | PN                 | 1CR     |       |          |               |
| (TITLE CONT.         |                   |        |                   |         |                   |       | 4. R               | ESUME D | ATE   | 5.<br>VE | RSION         |
| ATMOSPHE             | RE SOUNDING       |        |                   |         |                   |       | 0.9                | /01     | 172   |          | 002           |
| 6. PRINCIPAL II      | NVESTIGATOR       | 7. OR  | GANIZATION        |         |                   | 8. T  | ELEPHO             | NE      |       |          |               |
| HOUGHTON             | , J. T.           | OXF    | ORD UNIVERSI      | TY      |                   |       |                    |         |       |          |               |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION        |         |                   | 11. T | ELEPHO             | NE      |       |          |               |
| RODGERS,             | C. D.             | OXF    | ORD UNIVERSI      | TY      |                   |       |                    |         |       |          |               |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUME | BER    | 14. FLASH INDEX N | UMBER   | 15. START<br>DATE | 16. C | OMPLETION<br>DATE  | 17. ST  | ATU   | S        |               |
|                      |                   |        |                   |         |                   | ]     |                    | PRO     | POS   | SAL      |               |
| 18. MONITOR          |                   | 19. AG | ENCY              | 20. PGN | OFFICE            | 21. 7 | ELEPHO             | ONE     |       |          |               |
| SCHARDT,             | в.в.              | NAS    | A HDQTRS          | OA/     | ERN               | 20.   | 2-75               | 5-23    | 22    |          |               |
| 22. VENDOR           |                   |        | 23. LOCATION      |         |                   |       | 24. FLIGHT<br>DATE | 25      | . LEA | AD TI    | ME            |
|                      |                   |        |                   |         |                   |       | 197                | 74      |       |          |               |
| 26. INSTRUMEN        | T TYPE            |        |                   |         |                   |       |                    |         |       | 2<br>Si  | 7.<br>ECURITY |
| RADIOMET             | ER, IR            |        |                   |         |                   |       |                    |         |       |          | UNC           |
| 28. APPLICATIO       | N                 |        |                   | [2      | 29. SPACE         | CRAF  | T                  |         |       |          |               |
| MET, PLA             | NETARY ATMOS      | PHER   | ES                |         | NIMBU             | S-F   |                    |         |       |          |               |
| 30. PURPOSE          |                   |        |                   |         |                   |       |                    |         |       |          |               |

PRIMARY-TO OBTAIN RADIOMETRIC MEASUREMENTS OF TEMPERATURE IN TWO SELECTED REGIONS AT ALTITUDES BETWEEN 45 AND 70 KM ON A GLOBAL SCALE.

### 31. PRINCIPLES OF OPERATION

THE PRESSURE BROADENED EMISSION LINES OF CO2 BECOME SO NARROW IN THE UPPER STRATOSPHERE AND MESOSPHERE THAT CONVENTIONAL SPEC-TROMETERS AND INTERFEROMETERS HAVE INSUFFICIENT SPECTRAL RESOLU-TION TO SELECT THE RADIATION FROM THESE LEVELS. THE PRESSURE MODULATION TECHNIQUE PERMITS THE EXTENSION OF SELECTIVE CHOPPING TECHNIQUES TO THE HIGHER ALTITUDES. THE INSTRUMENT COMPRISES TWO SIMILAR RADIOMETER CHANNELS CONTAINING LEVELS, FILTERS, CO2 CELLS. CONICAL LIGHT PIPE TO WHICH DETECTORS ARE COUPLED. WEIGHTING FUNCTIONS FOR EACH RADIOMETER ARE SELECTED BY CHOOSING A MEAN CELL PRESSURE OF 0.325-MB FOR CHANNEL ONE AND 2.25 MB FOR CHANNEL TWO. THE LENGTH OF THE CELLS ARE THE SAME. SIX CENTI-THE HEIGHT OF THE WEIGHTING FUNCTION PEAKS ARE 65-KM FOR CHANNEL ONE AND 50-KM FOR CHANNEL TWO. THE MODULATION FRE-QUENCY IS 15-HZ. THIS WILL PERMIT MEASUREMENTS OF MESOSPHERIC TEMPERATURES TO BETTER THAN +-2 DEG K AT 65 KM AND +-0.2 DEG K AT 50-KM. PROPOSED DETECTORS ARE PYROELECTRIC (TRIGLYCINE SULPHATE).

# 32. PHENOMENA OBSERVED EARTH'S EMITTED RADIANCE AT 15 MICRONS 33. MEASUREMENT RANGE 15-MICRON CO2 BAND 34. PRECISION AND ACCURACY SEE ITEM 31

| 35. SPECTRAL     | RANGE             |  |       |                                       |           |        | 36. S | PECTRA                  | AL RE  | SOL       | UTION                 | 37. TIME  | CONSTANT     |
|------------------|-------------------|--|-------|---------------------------------------|-----------|--------|-------|-------------------------|--------|-----------|-----------------------|-----------|--------------|
| 15               |                   |  |       | MI                                    | CRO       | NS     |       |                         |        |           |                       |           |              |
| 38. FIELD OF V   | IEW               |  |       | 39. GR                                | DUND      | SWA    | ТН    |                         |        |           |                       |           |              |
| 10.              |                   |  | DEG   |                                       |           |        |       |                         |        |           |                       | _         |              |
| 40. ANGULAR RES  | -                 |  |       |                                       |           |        |       |                         |        |           |                       |           |              |
| 10               |                   | 100 NM                                       |       |                                       |           |        |       |                         |        |           |                       |           |              |
| 42. POINTING ACC | URACY             | 43. POINTING                                 | RATE  |                                       |           | ALTI   |       |                         |        |           | INCLINA               |           | ra a ch i ne |
|                  |                   |  |       |                                       | ME        | D C    | IRC   | ULAR                    |        | SU        | M-240                 | ICH KE    | TROGRADE     |
| 46. SPECIAL RE   | QUIRE             | MENTS  |       |                                       |           |        |       |                         |        | - Control |                       |           |              |
| 47. COMPONEN     | TC                |  |       |                                       |           |        | -     |                         |        |           |                       |           |              |
| RADIOMETE        |                   | ELECTRON                                     | TCS   |                                       | <u></u>   |        |       |                         |        |           |                       |           |              |
| 48. WEIGHT       |                   | LUME   | 1103  | 50. AV                                | FRAGE     | POWE   | R 5   | 1 STAND                 | BY POV | VER       | 52 PEA                | K POWER   | 53. MTBF     |
| 5 LB             | ing annuages,     | 0.25 CU                                      | I FT  |                                       |           | ATT    |       |                         |        |           | and the second second |           |              |
| 54. INTERFERENCE | 56. <sub>IN</sub> | MAGNETIC<br>ERFERENCE                        |       | UCLEAR<br>RFERENCE                    |           | 57. TH |       | CE                      | 58. S  | HIE       | LDING                 |           |              |
|                  |                   |  |       |                                       |           |        |       | - Addison of the second |        |           |                       |           |              |
| 59. CALIBRATI    | ON                |  |       | 60. (                                 | DATA      | RECO   | OVEF  | RY                      |        |           | 61. FRE               | QUENCY OF | OBSERVATION  |
|                  |                   |  |       | TEI                                   | LEM       | ETR    | Υ     |                         |        |           | CONT                  | INUOU     | S            |
| 62. TELEMETR     | Y REQL            | JIREMENTS                                    |       |                                       |           |        |       |                         |        |           |                       |           |              |
|                  |                   |  |       |                                       |           |        |       |                         |        |           |                       |           |              |
|                  |                   |  |       |                                       |           |        |       |                         |        |           |                       |           |              |
|                  |                   | <u>.</u>                                     |       |                                       |           | ·····  |       |                         |        |           | <del> </del>          |           |              |
| 63. ADVANTAG     | SES AN            | DLIMITATIO                                   | NS    |                                       |           |        |       |                         |        |           |                       |           |              |
|                  |                   |  |       |                                       |           |        |       |                         |        |           |                       |           |              |
| 64. REFERENC     | E C               |  |       |                                       |           | -1112  |       | <del></del>             |        |           |                       |           |              |
| O4. NEFEREIO     | LU                | <u>,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,</u> |       | · · · · · · · · · · · · · · · · · · · |           |        |       |                         |        |           |                       |           | ····         |
| PRELIMINA        | ADV I             | DATA SHE                                     | CT    | EUD I                                 | u T M     | BIIS.  | - F - | NOV                     |        | 10        | 70.                   |           |              |
| I NECESTICA      |                   | DATA SITE                                    | . ( 1 | 1010                                  | * * * * * | 003    | • •   |                         | • •    | • /       | 100                   |           |              |
| l                |                   |  |       |                                       |           |        |       |                         |        |           |                       |           |              |
| Ì                |                   |  |       |                                       |           |        |       |                         |        |           |                       |           |              |
| ļ                |                   |  |       |                                       |           |        |       |                         |        |           |                       |           |              |
| 65. HISTORICA    | L REM             | ARKS   |       |                                       |           | ,      |       | P<br>R                  | //     |           |                       |           |              |
|                  |                   |  |       |                                       |           |        |       |                         |        |           |                       |           |              |
|                  |                   |  |       |                                       |           |        |       |                         |        |           |                       |           |              |
|                  |                   |  |       |                                       |           |        |       |                         |        |           |                       |           |              |
| ļ                |                   |  |       |                                       |           |        |       |                         |        |           |                       |           |              |
|                  |                   |  |       |                                       |           |        |       |                         |        |           |                       |           |              |
|                  |                   |  |       |                                       |           |        |       |                         |        |           |                       |           |              |
|                  |                   |  |       |                                       |           |        |       |                         |        |           |                       |           |              |
|                  |                   |  |       |                                       |           |        |       |                         |        |           |                       |           |              |
| ļ                |                   |  |       |                                       |           |        |       |                         |        |           |                       |           |              |
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|                  |                   |  |       |                                       |           |        |       |                         |        |           |                       |           |              |
|                  |                   |  |       |                                       |           |        |       |                         |        |           |                       |           |              |
| ļ.               |                   |  |       |                                       |           |        |       |                         |        |           |                       |           |              |
| 1                |                   |  |       |                                       |           |        |       |                         |        |           |                       |           |              |
|                  |                   |  |       |                                       |           |        |       |                         |        |           |                       |           |              |
| . ,              |                   |  |       |                                       |           |        |       |                         |        |           |                       |           |              |
| 1                |                   |  |       |                                       |           |        |       |                         |        |           |                       |           |              |
|                  |                   |  |       |                                       |           |        |       |                         |        |           |                       |           |              |
| 1                |                   |  |       |                                       |           |        |       |                         |        |           |                       |           |              |
|                  |                   |  |       |                                       |           |        |       |                         |        |           |                       |           |              |
| 1                |                   |  |       |                                       | :         | :•     |       |                         |        |           |                       |           | -            |
| ł                |                   |  |       |                                       |           |        |       |                         |        |           |                       |           |              |

|                      |                   |        | J.,                |         |                   |        |            |   |     |                 |
|----------------------|-------------------|--------|--------------------|---------|-------------------|--------|------------|---|-----|-----------------|
| 1. TITLE             |                   |        |                    |         |                   |        | 2. /       | ACRONYM                                 | 3.  | EXP NO          |
| PASSIVE A            | MICROWAVE IMA     | GIN    | SSYSTEM            | _       |                   |        | PN         | 1 I S                                   |     |                 |
| (TITLE CONT.         |                   |        |                    |         |                   |        | 4. R       | ESUME DATE                              |     | 5.<br>VERSION   |
|                      |                   |        |                    |         |                   |        | 05         | /20/                                    |     | 0001            |
| 6. PRINCIPAL IN      | NVESTIGATOR       | 7. OR  | GANIZATION         |         |                   | 8. TE  | LEPHO      | NE                                      |     |                 |
| MATHEWS.             | R. E.             | MANI   | VED SPACECRAF      | T C     | ENTER             | 713    | 3-483      | 3-311                                   | ī   |                 |
| 9. CO-INVESTIG       |                   | 10. OR | GANIZATION         |         |                   | 11. T  | ELEPHO     | NE                                      |     |                 |
|                      |                   |        |                    |         |                   |        |            |   |     |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | MBER    | 15. START<br>DATE | 16. Ct | DATE DATE  | 17. STA                                 | TUS |                 |
|                      |                   |        |                    | ٠.      |                   |        |            | PREF                                    | LT  | TEST            |
| 18. MONITOR          |                   | 19. AG | ENCY               | 20. PGN | OFFICE            | 21. T  | ELEPHO     | ONE                                     |     |                 |
|                      |                   |        |                    |         | ,                 |        |            |   |     |                 |
| 22. VENDOR           |                   |        | 23. LOCATION       |         |                   |        | 24. FLIGHT | 25. (                                   | EAC | TIME            |
|                      |                   | ,      |                    |         | - ·               |        | 08/7       | /1                                      |     |                 |
| 26. INSTRUMEN        | T TYPE            |        |                    |         |                   |        |            |   |     | 27.<br>SECURITY |
| RADIOMET             | ER/IMAGER, M      | ICRO   | WAVE               |         | ,                 |        |            |   |     | UNC             |
| 28. APPLICATIO       |                   |        |                    |         | 29. SPACE         | CRAF   | T          |   |     | •               |
| ERSP.                |                   |        |                    |         | NP3A              | 4/C    |            |   |     |                 |
| 30. PURPOSE          |                   |        |                    |         | <del>,</del>      |        |            | • |     |                 |
| DRIMARY-             | TO GATHER TWO     | )-DI   | MENSTONAL . OF     | IANT    | ITATI             | VF.    | ANTE       | ΝΝΔ                                     | TEN | IPER-           |

PRIMARY-TO GATHER TWO-DIMENSIONAL, QUANTITATIVE, ANTENNA TEMPER-ATURE DATA OVER A VARIETY OF TARGETS.

### 31. PRINCIPLES OF OPERATION

THE RADIOMETER SUBSYSTEM INCLUDES THE RADOME, ANTENNA, AND RADI-THE ANTENNA WILL BE A TWO-DIMENSIONAL PHASED ARRAY, OMETER. ELECTRICALLY STEPPED TO ACHIEVE SCANNING TRANSVERSE TO THE THE ANTENNA WILL BE A DUAL-POLARIZATION DEVICE FLIGHT PATH. A SCAN ANGLE OF +-35 DEG TRANSVERSE TO WITH TWO OUTPUT PORTS. THE FLIGHT LINE WILL RESULT IN 50 SCAN POSITIONS. SCAN STEPS SHALL BE SIZED TO PRODUCE A 20 TO 30 PERCENT OVERLAP OF SUCCES-SIVE BEAMS: PROVISION IS MADE TO STOP THE BEAM SCAN AND MANUALLY STEP THROUGH ALL POSITIONS. THE RADIOMETER HAS A BANDWIDTH OF LESS THAN 150 MHZ (3-DB POINTS) RMS SENSITIVITY. THE AIRBORNE CONTROL AND DISPLAY SUBSYSTEM INCLUDES THE EQUIPMENT NECESSARY TO CONTROL AND MONITOR THE IMAGING RADIOMETER SUBSYSTEM WHICH INCLUDES A SWITCHABLE, REAL-TIME DIGITAL READOUT FOR MONITORING THE INSTRUMENT AND ENGINEERING OUTPUTS. A REAL-TIME IMAGE PRE-SENTATION PROVIDES QUICK-LOOK CAPABILITY AND A FRAMING CAMERA RECORDS DATA FOR VERIFICATION OF SYSTEM OPERATION. RADIOMETER OUTPUT DATA WILL BE RECORDED ON 35-MM BLACK-AND-WHITE FILM. ADAS NUMERIC DISPLAY WILL BE REQUIRED IN THE FILM RECORDING 🐭 UNIT. RECORDER WILL RECORD A MINIMUM OF 45 MINUTES OF DATA WHILE AT THE HIGHEST V/H RATE.

### 32. PHENOMENA OBSERVED

MICROWAVE RADIATION EMITTED FROM EARTH'S SURFACE

33. MEASUREMENT RANGE

SHF FREQUENCY

34. PRECISION AND ACCURACY

<2.0 DEG K AT U/H 0.2; <0.5 DEG K AT V/H 0.01;</p>

| Fac. 20. 2 =   |  |                             |   |                                       | 1                  |                                       |          |                             | 1                                      |             |
|--|--|-----------------------------|---|---------------------------------------|--------------------|---------------------------------------|----------|-----------------------------|--|-------------|
| 35. SPECTRAL RA  |  |                             |   |                                       |                    |                                       |          | LUTION                      |  | CONSTANT    |
| 10.69  |  | 150.                        | MH                                      |                                       | +-5                | · · · · · · · · · · · · · · · · · · · | MH       | 1                           | 10                                     | MILLISEC    |
| 38. FIELD OF VIE   |  |                             |   | UND SWA                               |                    |                                       |          |                             |  | - <u> </u>  |
| 1.8 B  |  |                             |   |                                       | 524                | FT                                    | FROM     | 10.0                        | 00 FT                                  |             |
| 40. ANGULAR RESOL  |  |                             |   |                                       | <u> </u>           |                                       |          |                             |  |             |
|  | DEG 314  |                             |   |                                       |                    | I TUI                                 |          | and a salety at a salety at |  |             |
| 42. POINTING ACCUR   |  | ITING RATE                  |   | 44. ALT                               | TUDE               |                                       |          | . INCLINA                   | ATION                                  |             |
| NA   | NA NA  |                             |   | NA                                    | ,                  |                                       | N        | Α                           | •                                      |             |
| 46. SPECIAL REO  | UIREMENTS  |                             |   |                                       | _                  |                                       |          |                             |  |             |
| - Committee - was insured in the control of the con | The state of the s | The second of the second of | representation near report reports from |                                       |                    |                                       |          |                             |  |             |
| 47. COMPONENTS   |  |                             | AB1 11                                  | . 6.15                                | * <del>*</del>     | - 44                                  |          |                             | ······································ |             |
| RADIOMETE  |  | NNA, DI                     |   |                                       |                    |                                       |          | T == == .                   |  | 1           |
| 48. WEIGHT 4   | 9. VOLUME  |                             | 50. AVE                                 | RAGE POWI                             | ER 51.             | STAND                                 | BY POWER | 52. PEA                     | KPOWER                                 | 53. MTBF    |
| BE BE  | - MAGNETIC   | [M                          | ICI EAR                                 | T T                                   | HERMAI             |                                       |          |                             | ***                                    | <u> </u>    |
| 54 INTERFERENCE  | 55. MAGNETIC<br>INTERFERENCE   | 56. INTER                   | CLEAR<br>REFERENCE                      | <sup>57.</sup> INT                    | HERMAL<br>RFERENCE | 1,-                                   | 58. SHI  | ELDING                      |  |             |
|  |  |                             |   |                                       |                    |                                       | L        |                             |  |             |
| 59. CALIBRATION  | <b>V</b> oj L H  |                             | 60. D                                   | ATA REC                               | OVERY              |                                       |          |                             |  | OBSERVATION |
| CO TEL CLICE   | 0F01115-1  | uro ne                      |   |                                       | 17.                |                                       |          | LUM                         | TINUOU                                 | 3           |
| 62. TELEMETRY  | KEQUIREME!   | NIS                         |   |                                       |                    |                                       |          | -                           |  |             |
| NA   |  |                             |   |                                       |                    |                                       |          |                             |  |             |
|  |  |                             |   |                                       |                    |                                       |          |                             |  |             |
| 63. ADVANTAGE  | C AND 1 11417  | ATIONS                      |   |                                       |                    |                                       |          |                             |  | 1           |
| US. ADVANTAGE  | S AND LIMIT  | W 110142                    |   |                                       |                    | -                                     |          |                             | ·                                      |             |
|  |  |                             |   |                                       |                    |                                       |          |                             |  |             |
| 64. REFERENCES   |  |                             |   |                                       | ·                  |                                       |          |                             | ****                                   |             |
|  |  | CADADTI                     | ITIC                                    |                                       | 141                | 0.0                                   | 2 5      | 7 70                        | 2_44                                   | <u> </u>    |
| 1. MSC AI  | KUKAPI I   | LAPABIL                     | LILES                                   | MANI                                  | JAL ,              | νν.                                   | . 2-5    | 1 10                        | Z-00                                   |             |
|  |  |                             |   |                                       |                    |                                       |          |                             |  |             |
|  |  |                             |   |                                       |                    |                                       |          |                             |  |             |
| 1  |  |                             |   |                                       |                    |                                       |          |                             |  |             |
|  |  |                             |   |                                       |                    |                                       |          |                             |  |             |
| 65. HISTORICAL   | DEMARKS  |                             |   | · · · · · · · · · · · · · · · · · · · |                    |                                       |          |                             |  |             |
| 65. HISTORICAL   | NEWARKS  |                             |   |                                       |                    |                                       |          |                             |  |             |
| <u> </u>   | -  |                             |   |                                       |                    | <u> </u>                              |          |                             |  |             |
| l  |  |                             |   |                                       |                    |                                       |          |                             |  |             |
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|  |  |                             |   |                                       |                    |                                       |          |                             |  |             |
|  |  |                             |   |                                       |                    |                                       |          |                             |  |             |
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|  |  |                             |   |                                       |                    |                                       |          |                             |  |             |
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|  |  |                             |   |                                       |                    |                                       |          |                             |  |             |
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|  |  |                             |   |                                       |                    |                                       |          |                             |  |             |
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|                      |                   |        | GREENDE   | LI, WID. | 20// 1  |                   |                   |                   |            |                 |
|----------------------|-------------------|--------|-----------|----------|---------|-------------------|-------------------|-------------------|------------|-----------------|
| 1. TITLE             |                   |        |           |          |         |                   |                   | 2.                | ACRONYM    | 3. EXP NO       |
| SURFACE-             | COMPOSITION M     | APP:   | ING PAD   | IOMET    | ER      |                   |                   | S                 | MR         | E23             |
| (TITLE CONT.)        |                   |        |           |          |         |                   | ٠,                | 4. 6              | ESUME DATE | 5.<br>VERSION   |
|                      |                   |        |           |          |         |                   |                   | 0.0               | 9/01/1     |                 |
| 6. PRINCIPAL IN      | IVESTIGATOR       | 7. OR  | GANIZATIO | N        |         |                   | 8. TI             | LEPHC             | NE         |                 |
| HOVIS, DE            | ₹. W. A.          | GODE   | DARD SP   | ACE F    | LT C    | ENTER             | 301               | L-982             | 2-5042     | ?               |
| 9. CO-INVESTIG       | ATOR              | 10. OR | SANIZATIO | N        |         |                   | 11. T             | ELEPHO            | NE         |                 |
| CALLAHAN             | W.R.              | FAIR   | RFIELD    | UNIVE    | RSIT    | Υ                 |                   |                   | 5-1011     |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH | INDEX NU | JMBER   | 15. START<br>DATE | 16. <sup>CC</sup> | DMPLETION<br>DATE | 17. STA1   | ับร             |
|                      |                   |        |           |          |         | 01/69             | 9                 |                   | ENG.N      | ODEL            |
| 18. MONITOR          |                   | 19. AG | ENCY      |          | 20. PGM | OFFICE            | 21. T             | ELEPH             | ÖNE        |                 |
| SCHARDT,             | B.8.              | NASA   | HDQTR     | S        | QA/     | EŔN               | 202               | 2-75              | 5-2322     | <b>)</b>        |
| 22. VENDOR           |                   |        | 23. LOCAT | ION      |         |                   | -                 | 24. FLIGH<br>DATE | 7 25. L    | EAD TIME        |
|                      |                   |        |           |          |         |                   |                   | 12/               | 72 33      |                 |
| 26. INSTRUMEN        | T TYPE            |        |           |          |         |                   |                   |                   |            | 27.<br>SECURITY |
| RADIOMETE            | R, THREE-CHA      | INNEL  | SCANN     | ING I    | NERA    | RED               |                   |                   |            |                 |
| 28. APPLICATIO       | N                 |        |           |          | 2       | 9. SPACE          | CRAF              | T                 |            |                 |
| ERSP'                |                   |        |           |          |         | NIMBUS            | SΕ                |                   |            |                 |
| 30. PURPOSE          |                   |        |           |          |         |                   |                   |                   |            |                 |
| PRIMARY-T            | O IDENTIFY V      | ARIC   | OUS IGN   | EOUS     | ROCK    | TYPES             | SFF               | ROM A             | N ORE      | ITING           |
| SPACECRAF            | T. TO PRODUC      | E A    | THERMA    | L MAP    | 0F      | THE SU            | JR F              | ACE (             | SIVING     | SOIL            |
| AND SEA S            | SURFACE TEMPE     | RATU   | JRES AN   | D ESP    | ECIA    | LLY ST            | TROM              | NG SI             | JRFACE     | TEM-            |
| PERATURE             | GRADIENTS.**      | **SEC  | ONDARY    | -TO T    | EST     | THE AF            | PLI               | CABI              | LITY       | OF THE          |
| RADIOMETE            | R TO MEASURE      | THE    | RESTS     | TRAHL    | EN (    | RESIDU            | JAL               | WAVE              | ES) OF     | ROCKS           |
| AND OTHER            | MATERIALS F       | ROM    | SPACE.    |          |         |                   |                   |                   |            |                 |
| 31. PRINCIPLES       | OF OPERATION      |        |           |          |         |                   |                   |                   |            |                 |
| MEASUREME            | NT OF THE RE      | STST   | RAHLEN    | OR R     | ESID    | JAL WA            | VE S              | OF                | VARIO      | ous             |
| IGNEOUS F            | ROCKS WILL PE     | RMIT   | ROCK      | IDENT    | IFIC.   | ATION             | , S1              | INCE              | THE V      | AVE-            |
| LENGTH OF            | THESE WAVES       | VAF    | IES WI    | TH TH    | E DE    | GREE C            | )F 1              | THE A             | CIDII      | Y OF            |
| THE ROCK.            | IGNEOUS ROC       | CKS A  | ARE DES   | CRIBE    | D BY    | A TER             | MIMS              | OLOC              | Y BAS      | SED ON          |
| THE SIO2             | OR 'ACIDIC'       | OXIC   | E CONT    | ENT.     | THE I   | RESTST            | TRAF              | ILEN              | LOWER      | S THE           |
| APPARENT             | TEMPERATURE:      | MEA    | SURED     | RADIO    | METR    | ICALLY            | / , E             | 3Y 12             | 2 TO 1     | .5 DE-          |
|                      | T CERTAIN WA      |        |           |          |         |                   |                   |                   |            |                 |
|                      | SIMULTANEOUS      |        |           |          |         |                   |                   |                   |            |                 |
|                      | MICRONS, AV       |        |           |          |         |                   |                   |                   |            | L RE-           |
| CORDS A L            | OWER APPAREN      | IT RA  | DIANT     | TEMPE    | RATU    | RE THA            | IN T              | THE (             | THER       | THE             |
| DIFFERENC            | E IS MOST LI      | KELY   | DUE T     | O A D    | IFFE    | RENCE             | IN                | EMI S             | SSIVII     | Y. THE          |
| PROPOSED             | RADIOMETER 1      | S AN   | OUTGR     | OWTH     | OF TI   | HE HRI            | R A               | AND A             | ARIR F     | LOWN            |
|                      | 1 AND 2. T        |        |           |          |         |                   |                   |                   |            |                 |
|                      | CANNING PERF      |        |           |          |         |                   |                   |                   |            |                 |
|                      | E SPATIAL RE      |        |           |          |         |                   |                   |                   |            |                 |
|                      | EFINING THE       |        |           |          |         |                   |                   |                   |            |                 |
|                      | THE ROTATING      |        |           |          |         |                   |                   |                   |            |                 |
|                      | CONTIGUOUS.       |        |           |          |         |                   |                   |                   |            |                 |
|                      | ON, DISTORTIC     |        |           |          |         |                   |                   |                   |            |                 |
|                      | USEFUL PORT       |        |           |          |         |                   |                   |                   |            |                 |
| 32. PHENOMENA        |                   |        |           |          |         |                   |                   |                   |            | _               |
| INFRARED             | RESTSTRAHLEN      | L (RE  | SIDUAL    | WAVE     | S) ni   | E. SURF           | ACE               | MA.               | TERTAL     | . S             |
| 33. MEASUREM         |                   |        |           |          |         |                   |                   |                   |            | <del></del>     |

DETECTIVITY (D\*) OF ABOUT 10 TO THE TENTH AT 100 DEG KELVIN.
34. PRECISION AND ACCURACY

NOISE EQUIVALENT DELTA T =0.17 DEG K AT 280 DEG K AND 10 MICRONS

| 36. SPECTRAL RANGE  8.3 TO 11.2 MICRONS  39. GROUND SWATH  60. BY 0.035DEG 700 NM BY 0.35 NM AT 600 NM ALTITUDE  40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION  0.035 DEG 0.35 NM BY 0.35 NM AT 600 NM ALTITUDE.  42. POINTING ACCURACY 43. POINTING RATE 44. ALTITUDE 45. INCLINATION  46. SPECIAL REQUIREMENTS  INSTRUMENT WILL REQUIRE A CLEAR DEEP SPACE VIEW  47. COMPONENTS  SCAN MIRROR, OPTICS 5 DETECTOR, ELECTRONICS, RADIANT COOLER.  48. WEIGHT 49. VOLUME 50. AVERAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF  55 LB 1.0 CU FT 8 WATTS 15 WATTS  54. INTERFERENCE 55. INTERFERENCE 57. INTERFERENCE 57. INTERFERENCE 58. SHIELDING  NONE NONE SO. DATA RECOVERY 61. FREQUENCY OF OBSERVATION  SEE ITEM 62 ON COMMAND  62. TELEMETRY REQUIREMENTS  2-CHANNEL XMITTER, 50 KHZ VIDEO PER CHANNEL, 40 DB SIN WILL REQUIRE 10 **4 SAMPLES PER SECOND PER CHANNEL FOR MAXIMUM OF 10 |
|--|
| 38. FIELD OF VIEW  39. GROUND SWATH  60. BY 0.035DEG 700 NM BY 0.35 NM AT 600 NM ALTITUDE  40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION  0.035 DEG 0.35 NM BY 0.35 NM AT 600 NM ALTITUDE.  42. POINTING ACCURACY 43. POINTING RATE 44. ALTITUDE 45. INCLINATION  46. SPECIAL REQUIREMENTS  INSTRUMENT WILL REQUIRE A CLEAR DEEP SPACE VIEW  47. COMPONENTS  SCAN MIRROR, OPTICS \$ DETECTOR, ELECTRONICS, RADIANT COOLER.  48. WEIGHT 49. VOLUME 50. AVERAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF  55 LB 1.0 CU FT 8 WATTS 15 WATTS  54. INTERFERENCE 55. INTERFERENCE 56. INTERFERENCE 57. INTERFERENCE 57. INTERFERENCE 58. SHIELDING  NONE NONE NONE SENSITIVE  59. CALIBRATION 60. DATA RECOVERY 61. FREQUENCY OF OBSERVATION  SEE ITEM 62 ON COMMAND  62. TELEMETRY REQUIREMENTS  2-CHANNEL XMITTER, 50 KHZ VIDEO PER CHANNEL, 40 DB SIN WILL RE-                                 |
| 60. BY 0.035DEG 700 NM BY 0.35 NM AT 600 NM ALTITUDE  40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION  0.035 DEG 0.35 NM BY 0.35 NM AT 600 NM ALTITUDE.  42. POINTING ACCURACY 43. POINTING RATE 44. ALTITUDE 45. INCLINATION  46. SPECIAL REQUIREMENTS  INSTRUMENT WILL REQUIRE A CLEAR DEEP SPACE VIEW  47. COMPONENTS  SCAN MIRROR, OPTICS \$ DETECTOR, ELECTRONICS, RADIANT COOLER.  48. WEIGHT 49. VOLUME 50. AVERAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF  55 LB 1.0 C U FT 8 WATTS 15 WATTS  54. INTERPERENCE 55. INTERPERENCE 56. INTERPERENCE 56. INTERPERENCE 57. INTERPERENCE 58. SHIELDING  NONE NONE NONE SENSITIVE  59. CALIBRATION 60. DATA RECOVERY 61. FREQUENCY OF OBSERVATION  SEE ITEM 62 ON COMMAND  62. TELEMETRY REQUIREMENTS  2 - CHANNEL XMITTER, 50 KHZ VIDEO PER CHANNEL, 40 DB SIN WILL RE-   |
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| 42. POINTING ACCURACY 43. POINTING RATE 44. ALTITUDE 45. INCLINATION  46. SPECIAL REQUIREMENTS  INSTRUMENT WILL REQUIRE A CLEAR DEEP SPACE VIEW  47. COMPONENTS  SCAN MIRROR, OPTICS \$ DETECTOR, ELECTRONICS, RADIANT COOLER.  48. WEIGHT 49. VOLUME 50. AVERAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF  55 LB 1.0 CU FT 8 WATTS 15 WATTS  54. INTERPERENCE 55. INTERPERENCE 56. INTERPERENCE 57. INTERPERENCE 58. SHIELDING  NONE NONE SENSITIVE  59. CALIBRATION 60. DATA RECOVERY 61. FREQUENCY OF OBSERVATION  SEE ITEM 62 ON COMMAND  62. TELEMETRY REQUIREMENTS  2 - CHANNEL XMITTER, 50 KHZ VIDEO PER CHANNEL, 40 DB SIN WILL RE-   |
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| 47. COMPONENTS  SCAN MIRROR, OPTICS \$ DETECTOR, ELECTRONICS, RADIANT COOLER.  48. WEIGHT 49. VOLUME 50. AVERAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF  55. LB 1.0 CU FT 8 WATTS 15 WATTS  54. INTERFERENCE 55. INTERFERENCE 56. INTERFERENCE 57. INTERFERENCE 58. SHIELDING  NONE NONE NONE SENSITIVE  59. CALIBRATION 60. DATA RECOVERY 61. FREQUENCY OF OBSERVATION  SEE ITEM 62 ON COMMAND  62. TELEMETRY REQUIREMENTS  2-CHANNEL XMITTER, 50 KHZ VIDEO PER CHANNEL, 40 DB SIN WILL RE-  |
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| 55 LB 1.0 CU FT 8 WATTS 15 WATTS  54. INTERFERENCE 55. INVERFERENCE 56. INVERFERENCE 57. INTERFERENCE 57. INTERFERENCE 58. SHIELDING  NONE NONE NONE SENSITIVE  59. CALIBRATION 60. DATA RECOVERY 61. FREQUENCY OF OBSERVATION  SEE ITEM 62 ON COMMAND  62. TELEMETRY REQUIREMENTS  2-CHANNEL XMITTER, 50 KHZ VIDEO PER CHANNEL, 40 DB SIN WILL RE-  |
| 54. INTERFERENCE   55. INTERFERENCE   56. INTERFERENCE   57. INTERFERENCE   58. SHIELDING    NONE   NONE   NONE   SENSITIVE    59. CALIBRATION   60. DATA RECOVERY   61. FREQUENCY OF OBSERVATION    SEE ITEM 62   ON COMMAND    62. TELEMETRY REQUIREMENTS    2 - CHANNEL XMITTER, 50 KHZ VIDEO PER CHANNEL, 40 DB SIN WILL RE-   |
| NONE NONE SENSITIVE  59. CALIBRATION 60. DATA RECOVERY 61. FREQUENCY OF OBSERVATION  SEE ITEM 62 ON COMMAND  62. TELEMETRY REQUIREMENTS  2-CHANNEL XMITTER, 50 KHZ VIDEO PER CHANNEL, 40 DB SIN WILL RE-   |
| 59. CALIBRATION    60. DATA RECOVERY   61. FREQUENCY OF OBSERVATION  |
| SEE ITEM 62 ON COMMAND  62. TELEMETRY REQUIREMENTS  2-CHANNEL XMITTER, 50 KHZ VIDEO PER CHANNEL, 40 DB SIN WILL RE-  |
| 62. TELEMETRY REQUIREMENTS 2-CHANNEL XMITTER, 50 KHZ VIDEO PER CHANNEL, 40 DB SIN WILL RE-   |
|  |
| QUIRE 10**4 SAMPLES PER SECOND PER CHANNEL FOR MAXIMUM OF 10   |
|  |
| MINUITES PER ORBIT; LESS IF RESOLUTION IS DEGRADED.  |
| 63. ADVANTAGES AND LIMITATIONS   |
| DAY AND NIGHT SCANNING, RADIATIVE COOLING, HIGH RESOLUTION,  |
| BASED ON HRIR AND MRIR EXPERIENCE; MOVING PARTS.   |
| 64. REFERENCES   |
| 1) HOVIS, W.A. AND CALLAHAN, W.R.: PROPOSAL FOR A HIGH RESOLUTION SURFACE COMPOSITION MAPPING RADIOMETER FOR NIMBUS E.***2) LYON,  |
| R.J.: FIELD INFRARED ANALYSIS OF TERRAIN, 1ST ANNUAL REPT, NASA  |
| GRANT NGR-05-020-115.***3) HOVIS, W.A., APPLIED OPTICS, V. 5,  |
| 1965.***4) NORDBERG, W., SCIENCE, V. 150, NO. 3696, 1965.  |
|  |
| 65. HISTORICAL REMARKS   |
| OUTGROWTH OF HRIR AND MRIR FLOWN ON NIMBUS 1 AND 2.  |
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### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771

| 1. TITLE             |  |        |                           |        |           |                  |                   |         |     | XP NO           |  |  |  |
|----------------------|--|--------|---------------------------|--------|-----------|------------------|-------------------|---------|-----|-----------------|--|--|--|
| SELECTIVE            | CHOPPER RAD                                      | IOME   | TER                       |        |           |                  | SCR               |         |     |                 |  |  |  |
| (TITLE CONT.         | )  |        |                           |        |           |                  | 4. RESU           | ME DATE |     | 5.<br>VERSION   |  |  |  |
|                      |  |        |                           |        |           |                  | 097               | 777     | 2 ( | 7 000           |  |  |  |
| 6. PRINCIPAL II      | NVESTIGATOR                                      | 7. OR  | ORGANIZATION 8. TELEPHONE |        |           |                  |                   |         |     |                 |  |  |  |
| HOUGHTON,            | DR.J. AND  | OXFC   | RD UNIVERSIT              | Υ,     | ENG.      |                  | 0X5-              | 9291    |     |                 |  |  |  |
| 9. CO-INVESTIG       | ATOR   | 10. OR | GANIZATION                |        |           | 11. T            | ELEPHONI          |         |     |                 |  |  |  |
| SMITH. DR            | .S/JOINT PI                                      | READ   | ING UNIVERSI              | TY,    | ENG.      |                  | RE8-              |         |     |                 |  |  |  |
| 12. CONTRACT<br>TYPE | TRACT 13. CONTRACT NUMBER 14. FLASH INDEX NUMBER |        |                           |        |           | 16. <sup>C</sup> | OMPLETION 17      | STAT    | rus |                 |  |  |  |
|                      |  |        |                           |        |           |                  | 0                 | PERA    | TI  | ONAL            |  |  |  |
| 18. MONITOR          |  | 19. AG | ENCY                      | 20. PG | M,OFFICE  | 21. T            | ELEPHON           | E       |     |                 |  |  |  |
| SCHARDT.             | B.B.   | NASA   | HDQTRS                    | OA/    | ERN       | 202              | -755-             | 2322    |     |                 |  |  |  |
| 22. VENDOR           |  |        | 23. LOCATION              |        |           |                  | 24 FLIGHT<br>DATE | 25. L   | EAD | TIME            |  |  |  |
| UNIVERSIT            | Y OF OXFORD                                      |        | OXFORD, ENGLA             | ND     |           |                  | 04/70             | NA      |     |                 |  |  |  |
| 26. INSTRUMEN        | T TYPE   |        |                           |        |           |                  |                   |         |     | 27.<br>SECURITY |  |  |  |
| RADIOMETE            | R, 3 DUAL-CH                                     | IANNE  | L INFRARED                |        |           |                  |                   |         |     | UNC             |  |  |  |
| 28. APPLICATIO       | N .  |        |                           |        | 29. SPACE | CRAF             | T                 |         |     | ì               |  |  |  |
| MET                  |  |        |                           |        | NIMBUS    | 5-4              |                   |         |     | AD TIME         |  |  |  |
| 30 PHRPOSE           |  |        |                           |        |           |                  |                   |         |     |                 |  |  |  |

PRIMARY- TO DETERMINE THE THREE-DIMENSIONAL TEMPERATURE STRUC-TURE OF THE EARTH'S ATMOSPHERE THROUGH THE USE OF THE 15 MICRON ABSORPTION BAND OF CO2 ON A GLOBAL BASIS BETWEEN THE GROUND OR HIGHEST CLOUD TOP AND 50-KM ALTITUDE.

### 31. PRINCIPLES OF OPERATION

THE INSTRUMENT HAS 6 CHANNELS, EACH WITH A FIELD-OF-VIEW OF 10 DEG AND ARE ARRANGED IN 3 UNITS OF 2. THE BASIC SPECTRAL SELEC-TION IS ACHIEVED BY INTERFERENCE FILTERS OF 2 TYPES. THREE CHAN-NELS USE FILTERS 4 INV. CM. WIDE, AND 3 USE FILTERS 10 INV. CM. WIDE. FOR THE NARROW BAND CHANNELS, A TECHNIQUE OF SELECTIVE CHOPPING BY CO2 IS USED TO FURTHER DELINEATE THE ENERGY COLLECT-THE FILTERED RADIATION IS SWITCHED BETWEEN A CELL CONTAIN-ING CO2 AND AN EMPTY CELL. THIS PERMITS ONLY WAVELENGTHS AB-SORBED BY CO2 TO BE CHOPPED. BY THIS MEANS, THE ENERGY COLLECT-ED IS EQUIVALENT TO THAT FROM AN INTERVAL OF 1.3 INV. CM. OF THE NARROW CHANNELS THE WEIGHTING FUNCTION IS FURTHER SHARP-ENED BY ADDING A SMALL AMOUNT OF CO2 AT VERY LOW PRESSURE TO THE EMPTY CELL. TEMPERATURES CAN BE OBTAINED UP TO HEIGHTS OF 27 NM USING THE WEIGHTING FUNCTIONS. FOR LOWER ALTITUDE MEASUREMENTS HEIGHT RESOLUTION IS INCREASED FOR THE REMAINING 1 NARROW AND 3 BROAD CHANNELS BY USING A SINGLE CO2 CELL TO ABSORB THE CENTRAL PORTIONS OF THE LINES. THE OPTICAL SYSTEM CONSISTS OF A MOVABLE MIRROR, CHOPPERS, GERMANIUM LENSES, FILTERS, AND A LIGHT PIPE TO CONDENSE RADIATION ONTO A THERMISTOR BOLOMETER. THE OUTPUT OF EACH CHANNEL IS SAMPLED ONCE EACH SECOND.

32. PHENOMENA OBSERVED

RADIATION FROM ATMOSPHERIC CARBON DIOXIDE.
33. MEASUREMENT RANGE

IR RADIATION IN 15 MICRON BAND.

34. PRECISION AND ACCURACY

| 35. SPECTRAL RA   | ANGE                         |                        |                | 36. SPECTRA         | L RESOL   | JTION                                    | 37. TIME (     | CONSTANT                                 |  |  |
|---|------------------------------|------------------------|----------------|---------------------|-----------|--|----------------|--|--|--|
| 14.5  |                              |                        | ICRONS         |                     | PER       | CENT                                     | 1.0            | SECONDS                                  |  |  |
| 38. FIELD OF VIE  | :W                           |                        | ROUND SWA      |                     |           |  |                |  |  |  |
| 40. ANGULAR RESOL   | UTION 41. SPATIA             | DEG   81<br>L RESOLUTI | NM DIAM        | 1 CIRCLE            | FROM      | 600                                      | NM AL          | LIUUE                                    |  |  |
|   | DEG 81 NM                    |                        |                | TITUDE              |           |  |                | ·  |  |  |
| 42. POINTING ACCUR  |                              |                        | 44. ALT        |                     | 45.       | INCLINA                                  | TION           |  |  |  |
|   |                              |                        | MED            | CIRCULA             | R SU      | N-SYN                                    | CH RI          | TROGRADE                                 |  |  |
| 46. SPECIAL REQ   |                              |                        |                |                     |           |  | · · · <u> </u> |  |  |  |
|   | R HOUSINGS                   | CANNOT                 | EXCEE          | ) 40 DEG            | ; C       | <del></del>                              |                |  |  |  |
| 47. COMPONENTS  |                              | 00 057                 |                | EL CCTOC            | NI T C C  |  | <u> </u>       |  |  |  |
|   | TERS. MIRR<br>19. volume     |                        |                | ER 51. STAND        |           | 52. PEA                                  | K POWER        | 53. MTBF                                 |  |  |
| 34 LB   | 0.5 C                        | UFT                    | 5 WATI         | rs                  |           |  |                | a souther as a                           |  |  |
| 54. INTERFERENCE  | 55. MAGNETIC<br>INTERFERENCE | 56. NUCLEAR            | 57. INT        | HERMAL<br>ERFERENCE | 58. SHIEI | DING                                     |                | 4  |  |  |
|   |                              |                        | ~ <u>~~~~~</u> | SITIVE              |           |  |                |  |  |  |
| 59. CALIBRATIO  |                              |                        | D. DATA REC    |                     |           | +  | 6              | BSERVATION                               |  |  |
| SPECIFIC S  |                              |                        | FLAYED         | TELEMET             | RY        | ICONI                                    | INUOUS         | \$                                       |  |  |
| 62. TELEMETRY REQUIREMENTS  6 CHANNELS SAMPLED ONCE EACH SECOND WITH ONE-HALF PERCENT |                              |                        |                |                     |           |  |                |  |  |  |
| ACCURACY  | S SAMPLED                    | UNCE EA                | CH SEC         | JNU WITE            | I UNE-    | MALF                                     | PERCEI         | <b>'</b> '                               |  |  |
| 63. ADVANTAGE   | S AND LIMITATIO              | ONS                    |                |                     |           | ,  |                |  |  |  |
| BETTER SPE  | ECTRAL RES                   | OLUTION                | THAN (         | ONVENTI             | ONAL      | SPECT                                    | ROMETE         | RS OR                                    |  |  |
| INTERFERON<br>64. REFERENCES  | METERS. L                    |                        |                |                     |           |  |                |  |  |  |
| 1) SMITH,   | F.W. SCR                     | SUBSYS                 | TEM DIE        | RECTORY             | (PRFI     | IM) G                                    | FNERAL         | FIFC-                                    |  |  |
| TRIC CO.,   |                              |                        |                |                     |           |  |                |  |  |  |
| INTERIM RE  |                              |                        |                |                     |           |  |                |  |  |  |
| REPORT NO.  |                              |                        |                |                     |           |  |                |  |  |  |
| MENTS FOR   |                              | S. PRES                | ENTED A        | T-13TH              | ANN T     | ECH S                                    | YMP OF         | SPIE,                                    |  |  |
| AUG 19. 19.65. HISTORICAL   |                              |                        |                |                     |           |  |                |  |  |  |
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### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER

|                      |                   |        | GREENBELI, MD. 2     | 20//1 |                   |         |                    |                        |      |                 |  |
|----------------------|-------------------|--------|----------------------|-------|-------------------|---------|--------------------|------------------------|------|-----------------|--|
| 1. TITLE             |                   |        |                      |       |                   |         | 2. /               | ACRONYM                | 3. E | XP NO           |  |
| SELECTIV             | E CHOPPER RA      | DIOM   | ETER                 |       |                   |         | 50                 | CR                     | ΕO   | 5               |  |
| (TITLE CONT.         | )                 |        | •                    |       |                   |         |                    | 4. RESUME DATE VERSION |      |                 |  |
|                      |                   |        |                      |       |                   |         | 709                | 3/01/                  | 72   | 2009            |  |
| 6. PRINCIPAL IN      | IVESTIGATOR       | 7. OR  | GANIZATION           |       |                   | 8. TEL  | .EPHO              | PHONE                  |      |                 |  |
| HOUGHTON             | , DR.J. AND       | CLA    | RENDON LAB, 0        | XFOR  | D, ENG            |         | OX                 | 9291                   |      |                 |  |
| 9. CO-INVESTIG       | ATOR              |        | RGANIZATION 11. TELI |       |                   |         |                    | NE                     |      |                 |  |
|                      | R.S/JOINT PI      | REA    | DING UNIV, RE        | ADIN  |                   |         |                    | 3-4372                 |      |                 |  |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU   | MBER  | 15. START<br>DATE | 16. COM | PLETION<br>DATE    | 17. STAT               | US   |                 |  |
|                      |                   |        |                      |       |                   |         | ENG.MODEL          |                        |      |                 |  |
| 18. MONITOR          |                   | 19. AG | ENCY                 | L     | OFFICE            |         |                    | HONE                   |      |                 |  |
| SCHARDT,             | 8.8.              | NAS    | A HDQTRS             | DAZ   | ERN               | 202     | <b>-7</b> 5        | 5-2322                 | 2    |                 |  |
| 22. VENDOR           |                   |        | 23. LOCATION         |       |                   | . [ :   | 24. FLIGHT<br>DATE | 25. L                  | EAD  | TIME            |  |
| ELLIOT-A             | UTOMATION         |        | ENGLAND              |       |                   |         | 12/                | 72 30                  | MO   | NTHS            |  |
| 26. INSTRUMEN        |                   |        |                      |       |                   |         |                    |                        |      | 27.<br>SECURITY |  |
| RADIOMET             | ER, 13-CHANN      | EL I   | NFRARED SELEC        | CTIV  | E CHOI            | PPER    |                    |                        |      | UNC             |  |
| 28. APPLICATIO       | N                 |        |                      | 2     | 9. SPACE          | CRAFT   |                    |                        |      |                 |  |
| MET                  |                   |        |                      |       | NIMBU.            | SE      |                    |                        |      |                 |  |
| 30. PURPOSE          |                   |        |                      |       |                   |         |                    |                        |      |                 |  |
| PRIMARY .            | - TO OBSERVE      | ATM    | SPHERIC TEM          | PERA  | TURE              | STRU    | CTUF               | RE UP                  | TO   |                 |  |

PRIMARY - TO OBSERVE ATMOSPHERIC TEMPERATURE STRUCTURE UP TO 50 KM IN ALTITUDE \*\*\* SECONDARY-TO PROVIDE QUANTITATIVE INFORMA-TION ABOUT THE DENSITY AND DISTRIBUTION OF CIRRUS CLOUDS AND TROPOSPHERIC WATER VAPOR.

### 31. PRINCIPLES OF OPERATION

INSTRUMENT OBSERVES IN 16 CHANNELS FROM 2 TO 100 MICRONS. EIGHT CHANNELS OBSERVE IN THE 15-MICRON CO2 BAND. 1 SOUNDS WATER VAPOR DISTRIBUTION, ITS A CLEAR WINDOW CHANNEL, 2 OBSERVE REFLECTED SUNLIGHT, 2 CIRRUS CLOUDS, AND 2 NIGHT EMISSION FROM CLOUDS. CHANNEL SEPARATION IS OBTAINED BY OPTICAL FILTERING. THERE ARE 4 GROUPS OF 4 CHANNELS EACH: A)13.8-14.8, B)15.0, C)11-1-100.AND D)2.08-3.5 MICRONS. THE SENSOR IS BASED ON MIRROR OPTICS AND TIME-MULTIPLEXING OF THE 4 CHANNELS WITHIN EACH GROUP. THERE IS 1 DETECTOR AND ELECTRONIC SYSTEM FOR EACH GROUP. A FILTER WHEEL MOUNTED IN FRONT OF EACH DETECTOR CONTAINS 4 FILTERS (OR CO2 CELLS IN THE GROUP B CHANNELS) WHICH DEFINE THE 4 SPECTRAL INTER -VALS FOR THAT GROUP. IN THE LOWER CO2 TEMPERATURE SOUNDING CHANNELS, GROUP A, THE WEIGHTING FUNCTIONS MAY BE SHARPENED BY ABSORBING OUT THE LINE CENTERS OF EACH BAND BY MEANS OF A CO2 PATH LENGTH WITHIN THE OPTICAL SYSTEM. CONVERSELY, IN THE GROUP B CHANNELS, FOR SOUNDING IN THE UPPER ATMOSPHERE, GOOD VERTICAL RESOLUTION IS OBTAINED USING A DIFFERENCE TECHNIQUE BETWEEN AD-JACENT CHANNELS BUT WITH INCREASING AMOUNTS OF THE LINE CENTERS ABSORBED OUT BY MEANS OF THE CO2-FILLED CELLS. THIS IS THE SE-<u>LE</u>CTIVE CHOPPING PRINCIPLE FROM WHICH THE INSTRUMENT IS NAMED.

### 32. PHENOMENA OBSERVED

RADIATION FROM EARTH, ATMOSPHERE, CLOUDS

### 33. MEASUREMENT RANGE

0-200 ERGS/SEC/SQ-CM/STERADIAN/CM\*\*-1

### 34. PRECISION AND ACCURACY

BETTER THAN 0.25 ERG/SEC/SQ-CM/STERADIAN/CM\*\*-1

| 35. SPECTRAL RANGE      |   |         | 20         | SPECTRAL   | BESOL       | ITION      | 37 TIME     | CONSTANT       |
|-------------------------|---|---------|------------|------------|-------------|------------|-------------|----------------|
|                         | 100                                     | MT      | CRONS      | JEC I NAL  | . nesult    | J I I UN   |             | SEC            |
| 2. TO                   |   |         | UND SWATH  |            |             |            | L.          | <u> </u>       |
| 1.5 BY                  |   |         | AND 42     |            | OM AO       | O NM       | AI TI T     | UDF            |
| 40. ANGULAR RESOLUTION  |   |         |            | 1413 3 1   | <u> </u>    | . 🔾 . 1917 | <u> </u>    |                |
| 1.544 DEG               |   |         |            | DRRIT      |             |            |             |                |
| 42. POINTING ACCURACY 4 |   | 16.     | 44. ALTITU |            | <del></del> | INCLINA    | TION        |                |
| NA                      | NA                                      |         | MED        |            |             |            |             | GH NOON        |
| 46. SPECIAL REQUIREN    |   |         |            |            |             |            |             |                |
| 4 FILTER WHEE           | ELS TEMP MU                             | ST BI   | E KEPT     | WITHIN     | 0.1         | C DE       | G DF D      | ETECTORS       |
| 47. COMPONENTS          | on                                      |         |            |            |             |            |             |                |
| RADIOMETER WI           | TH ASSOCIA                              |         |            |            |             |            |             |                |
| 48. WEIGHT 49. VOL      | UME                                     | 50. AVE | RAGE POWER | 51. STANDB | Y POWER     | 52. PEA    | KPOWER      | 53. MTBF       |
| 25 LB                   | 0.31 CU FT                              |         | 7 WATTS    |            | ATTS        |            | WATTS       |                |
| <del></del>             | AGNETIC 56. NUC<br>REFERENCE 56. INTERE |         | 57. THERM  |            | 58. SHIE    | LDING      |             |                |
| NONE NON                | <u> I NON</u>                           |         |            | ITIVE      |             | T          | OUENG:: 05  | ancent A Trans |
| 59. CALIBRATION         |   |         | ATA RECOV  |            |             | 61. FRE    | UUENCY OF ( | DBSERVATION    |
| BLACK BODY; S           |   | DEI     | LAYED T    | ELEMET     | RY          | 1          |             |                |
| 62. TELEMETRY REQUI     |   |         |            | CALT AC    | <u> </u>    |            | 401.50      | 1 050          |
| 7 ANALOGUE CH           |   |         | -          |            |             |            |             |                |
| SECOND FOR RA           |   |         | •          | t CHAN     | NELS        | FUR !      | MUNITO      | KING;          |
| 33 CHANNELS C           |   | I EL E  | MEIKY.     |            | ·           |            |             |                |
|                         |   | COC -   | CAN PE     | TAIMECT    | ICATE       | n c        | 000 04      | DIONETOIC      |
| UPPER LEVELS            |   |         |            |            |             |            |             |                |
| 64. REFERENCES          | TE CALIBRAT                             | TO:A (  | COMMUN.    | IU ALL     | CHAY        | INEL 3     | · MUYI      | NO PARIS       |
| 1) PROPOSAL F           | OR SELECTI                              | VE C    | HOPPER     | RADIOM     | FTFD        | FOP        | WATED       | VAPOR.         |
| CLOUD, AND AT           |   |         | •          |            |             |            |             | , ,            |
| REPORT - APPL           |   |         |            |            |             |            |             | 1              |
| WATCH, JUN 67           |   |         |            |            |             |            |             |                |
| ON NIMBUS D.            |   |         |            |            |             |            |             |                |
| WITH BALLOON-           |   |         |            |            |             |            |             |                |
| 65. HISTORICAL REMA     |   |         |            |            |             |            |             |                |
|                         |   |         |            |            |             |            |             |                |
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|----------------------|---------------|-----------|-----------|-------|------|-------------------|------------------|-------------------|-----------------|-------------------|-------|-----------------|--|
| 1. TITLE             |               |           |           |       |      |                   |                  |                   | 2.              | ACRONY            | м 3.  | EXP NO          |  |
| SCANNING             | RADIOMETER    |           |           |       |      |                   |                  |                   | S               | R                 |       |                 |  |
| (TITLE CONT.         | )             |           |           |       |      |                   |                  |                   | 4.              | RESUME DA         | tE.   | 5.<br>VERSION   |  |
|                      |               |           |           |       |      |                   |                  |                   | 0               | 09/01/72 00       |       |                 |  |
| 6. PRINCIPAL II      | NVESTIGATOR   | 7. OR     | GANIZATIO | N     |      |                   |                  | 8. T              | ELEPH           | ONE               |       |                 |  |
| GEMUNDER             | , G. (T. MON) | GODI      | DARD SI   | PAC   | E FL | T CE              | NTER             | 30                | 01-982-5042     |                   |       |                 |  |
| 9. CO-INVESTIG       | ATOR          | 10. OR    | GANIZATIO | ON    |      |                   |                  | 11. T             | ELEPH           | ONE               |       |                 |  |
|                      |               |           |           |       |      |                   |                  |                   |                 |                   |       |                 |  |
| 12. CONTRACT<br>TYPE | ER            | 14. FLASH | IND       | EX NU | MBER | 15. START<br>DATE | 16. <sup>C</sup> | OMPLETION<br>DATE | 17. ST          | ATUS              |       |                 |  |
| FP                   |               |           |           |       |      |                   |                  |                   |                 | OPE               | RAT   | IONAL           |  |
| 18. MONITOR          |               | 19. AG    | ENCY      |       |      | 20. PGM           | OFFICE           | 21. 1             | ELEPH           | IONE              |       |                 |  |
| GARBACZ,             | М.            | NAS       | A HDQTI   | RS    |      | OA/E              | ŔO               | 202               | 2-75            | 5-23              | 22    |                 |  |
| 22. VENDOR           |               |           | 23. LOCA  | TION  | )    |                   |                  |                   | 24 FLIG<br>DATE | <sup>+</sup> ፣ 25 | . LEA | D TIME          |  |
| SANTA BA             | RBARA RES CEN | NTER      | GOLET     | Α,    | CALI | FOR               | AIV              |                   | 1/7             | ΰ N               | A     |                 |  |
| 26. INSTRUMEN        | IT TYPE       |           |           |       |      |                   |                  |                   |                 |                   |       | 27.<br>SECURITY |  |
| RADIOMET             | ER, VISIBLE/  | IR S      | CANN IN   | G     |      |                   |                  |                   |                 |                   |       | UNC             |  |
| 28. APPLICATIO       | N .           |           |           |       |      | 2                 | 9. SPACE         | CRAF              | T               |                   |       |                 |  |
| MET, ATM-            | PHYS, PART-FL | )         |           |       |      |                   | TOS-             | 1 .               |                 |                   |       |                 |  |
| 20 01100000          |               |           |           |       |      |                   |                  |                   |                 |                   |       |                 |  |

### **30. PURPOSE**

PRIMARY-TO MEASURE EMITTED RADIATION FROM THE EARTH DURING DAY AND NIGHT AND TO MEASURE REFLECTED RADIATION FROM THE EARTH DURING DAYTIME. THE SYSTEM PERMITS DETERMINATION OF THE SURFACE TEMPERATURE OF THE GROUND, SEA, OR CLOUD TOPS THAT ARE VIEWED BY THE RADIOMETER.

### 31. PRINCIPLES OF OPERATION

THIS SCANNING RADIOMETER SYSTEM CONSISTS OF 2 REDUNDANT RADIOM-ETERS WITH SUPPORTING COMPONENTS. EACH HAS 2 DATA CHANNELS: IR (10.5-12.5 MICRONS) AND VISIBLE (0.52-0.73 MICRON) BOTH WITH AN INSTANTANEOUS FOV OF 0.3 DEG. THE RADIOMETER SCANS THE EARTH'S SURFACE FROM HORIZON TO HORIZON, PERPENDICULAR TO THE ORBITAL PLANE BY MEANS OF A CONTINUOUSLY ROTATING MIRROR (48 RPM) WHICH IS INCLINED 45 DEG TO ITS AXIS OF ROTATION. THE IR CHAN-NEL IS CALIBRATED AT THE COLD EXTREME BY MEASURING THE RESPONSE TO OUTER SPACE AND ON THE WARM SIDE BY MEASURING THE IR RADIA-TION FROM INSIDE THE RADIOMETER HOUSING. THE VISIBLE CHANNEL IS CALIBRATED SEPARATELY. IN OPERATION, RADIATION REFLECTS FROM THE ROTATING MIRROR TO THE COLLECTING OPTICS, A 5-IN DIAM CAS-SEGRAINIAN SYSTEM, AND IS THEN FOCUSED ONTO THE BEAM SPLITTER (DICHROIC MIRROR). THE IR PASSES THROUGH AND IS MEASURED BY A SOLID-STATE RADIANT ENERGY DETECTOR (THERMISTOR BOLOMETER). THE VISIBLE IS REFLECTED FROM THE BEAM SPLITTER AND PASSES THROUGH A 0.52-0.73 MICRON WAVELENGTH FILTER ONTO A PHOTOVOLTAIC SILICON DETECTOR. DATA ARE RECORDED ON TAPE. THE IR CHANNEL ALSO IS COMPATIBLE WITH THE APT SYSTEM PRODUCING A DIRECT READOUT IR SYSTEM.

### 32. PHENOMENA OBSERVED

ENERGY IN THE INFRARED AND VISIBLE REGION OF THE SPECTRUM

### 33. MEASUREMENT RANGE

VISIBLE BRIGHTNESS: 50-10,000 FT-LAMBERTS; IR TEMP: 180-330 DEG K

### 34. PRECISION AND ACCURACY

1.0 K DEG AT 300 DEG K; 4.0 K DEG AT 185 DEG K

| 35. SPECTRAL RANGE                                 | 26 00507044 05004                         | ON THE CONSTANT                       |
|--|---|---------------------------------------|
| 0.52 TU 12.5                                       | MICRUNS                                   | ON 37. TIME CONSTANT                  |
|  |   |                                       |
| 38. FIELD OF VIEW DEG                              | 39. GROUND SWATH LIMB-TU-LIMB (4100 NM) F | DOM 750 NM ALT                        |
|  |   | NOS (JU SET                           |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES             |   | ACTITUDE                              |
|  | LE, 4 NM IR FROM 750 NM                   | ALTITUDE                              |
| 42. POINTING ACCURACY 43. POINTING RATI            |   | LINATION                              |
|  | MED CIRCULAR SUN-                         | SYNCH RETRUGRADE                      |
| 46. SPECIAL REQUIREMENTS                           |   |                                       |
| RADIOMETERS MUST BE ABL                            | E TO SCAN 150 DEG WITHOU                  | OBSTRUCTIONS                          |
| 47. COMPONENTS                                     |   |                                       |
| 2 RADIUMETER-ELECTRUNIC                            | S SYSTEMS, PRUCESSUR, TA                  | PE RECURDER                           |
| 48. WEIGHT 49. VOLUME 40 LB 0.5 CU FT              | 50. AVERAGE POWER 51. STANDBY POWER 52.   | PEAK POWER 53. MTBF                   |
| 54. INTERFERENCE 55. INTERFERENCE 56. INTERFERENCE | ICLEAR 57. THERMAL 58. SHIELDII           | NG                                    |
| INTERPERENCE INTERPERENCE INTER                    | SENSITIVE                                 |                                       |
| 59. CALIBRATION                                    |   | . FREQUENCY OF OBSERVATION            |
| 2 COLD, I HOT EACH SCAN                            |   |                                       |
| 62. TELEMETRY REQUIREMENTS                         | TO SERVICE MILE MARKET BITTE IN           |                                       |
| BASEBAND BANDWIDTH IS 7                            | . 2 KH7.                                  |                                       |
| BASEBAND BANDWIDIN 15                              | • C NIIL •                                |                                       |
|  |   |                                       |
| 63. ADVANTAGES AND LIMITATIONS                     |   |                                       |
|  | RACY IN VISIBLE THAN PRE                  | SEMT CAMEDAS NOT                      |
| •  |   | · · · · · · · · · · · · · · · · · · · |
|  | VIDES DAY AND NIGHT REAL                  | TIME IN DATA.                         |
| 64. REFERENCES                                     | AN THE THANKS                             |                                       |
|  | OR THE IMPROVED TOSTITOS                  |                                       |
| 1  | CONTRACT NO. NAS5-9034,                   |                                       |
| · ·  | ICAL IR INSTRUMENTS FOR                   |                                       |
|  | ECH. SYMP. OF SOCIETY OF                  | PHOTO-OPTICAL                         |
| INSTRUMENTATION ENGINEE                            | RS, AUG. 22, 1968.                        |                                       |
|  |   |                                       |
| 65. HISTORICAL REMARKS                             |   |                                       |
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### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER

|                      |                   |        | GREENBELI, MD. 2             | 20//1   |                   |       |                    |                   |        |                 |  |
|----------------------|-------------------|--------|------------------------------|---------|-------------------|-------|--------------------|-------------------|--------|-----------------|--|
| 1. TITLE             |                   |        |                              |         |                   |       | 2. /               | CRONYM            | 3. E   | XP NO           |  |
| SCANNING             | RADIOMETER        |        |                              |         |                   |       | SR                 |                   |        |                 |  |
| (TITLE CONT.         | ) , ,             |        |                              |         | <u></u>           |       | 4. R               | ESUME DATE        | $\neg$ | 5.<br>VERSION   |  |
|                      |                   |        |                              |         |                   |       | 0.9                | 09/01/72 0007     |        |                 |  |
| 6. PRINCIPAL II      | NVESTIGATOR       | 7. OR  | 7. ORGANIZATION 8. TELEPHONE |         |                   |       |                    |                   |        |                 |  |
| GEMUNDER             | G. (T.MON)        | GODE   | DARD SPACE FL                | TC      | ENTER             | 301   | <del>-</del> 982   | -5042             |        |                 |  |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION                   |         |                   | 11. T | ELEPHO             | NE                |        |                 |  |
|                      |                   |        |                              |         |                   |       |                    |                   |        |                 |  |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU           | MBER    | 15. START<br>DATE | 16, C | OMPLETION<br>DATE  | TETION 17. STATUS |        |                 |  |
| FP                   |                   |        |                              |         | <u></u>           |       |                    | OPERATIONAL       |        |                 |  |
| 18. MONITOR          |                   | 19. AG | ENCY                         | 20. PGI | M OFFICE          | 21. 1 | <b>TELEPHONE</b>   |                   |        |                 |  |
| GARBACZ,             | M •               | NAS    | A HDQTPS                     | UA/     | ERO               | 202   | <del>2-</del> 75 5 | -2322             |        |                 |  |
| 22. VENDOR           | ·                 |        | 23. LOCATION                 |         |                   |       | 24. FLIGHT<br>DATE | 25. L             | EAD    | TIME            |  |
| SANTA BAR            | BARA RES CEN      | ITER   | GOLETA, CALIF                | •       |                   |       | 12/7               | O NA              |        |                 |  |
| 26. INSTRUMEN        | T TYPE            |        |                              |         | 4.                |       |                    |                   |        | 27.<br>SECURITY |  |
| RADIOMETE            | P, VISIBLE/I      | R SC   | ANNING                       |         |                   |       |                    |                   |        | UNC             |  |
| 28. APPLICATIO       | N                 |        |                              |         | 29. SPACE         | CRAF  | T                  |                   |        |                 |  |
| MET, ATM-            | -PHYS, PART-F     | -LD    |                              |         | NOAA-             | -1    |                    |                   |        |                 |  |
| 30. PURPOSE          |                   |        |                              |         |                   |       |                    |                   |        |                 |  |
| DRIMADV-1            | O MEASURE EN      | ATTT   | D PADIATION                  | ERN     | M THE             | EAG   | THE                | HID TNIC          |        | <u> </u>        |  |

PRIMARY-TO MEASURE EMITTED RADIATION FROM THE EARTH DURING DAY AND NIGHT AND TO MEASURE REFLECTED RADIATION FROM THE EARTH DURING DAYTIME. THE SYSTEM PERMITS DETERMINATION OF THE SURFACE TEMPERATURE OF THE GROUND, SEA, OR CLOUD TOPS THAT ARE VIEWED BY THE RADIOMETER.

### 31. PRINCIPLES OF OPERATION

THIS SCANNING RADIOMETER SYSTEM CONSISTS OF 2 REDUNDANT RADIOM-ETERS WITH SUPPORTING COMPONENTS. EACH HAS 2 DATA CHANNELS: IR (10.5-12.5 MICRONS) AND VISIBLE (0.52-0.73 MICRON) BOTH WITH AN INSTANTANEOUS FOV OF 0.3 DEG. THE RADIOMETER SCANS THE EARTH'S SURFACE FROM HORIZON TO HORIZON, PERPENDICULAR TO THE ORBITAL PLANE BY MEANS OF A CONTINUOUSLY ROTATING MIRROR (48 RPM) WHICH IS INCLINED 45 DEG TO ITS AXIS OF ROTATION. THE IR CHAN-NEL IS CALIBRATED AT THE COLD EXTREME BY MEASURING THE RESPONSE TO OUTER SPACE AND ON THE WARM SIDE BY MEASURING THE IR RADIA-TION FROM INSIDE THE RADIOMETER HOUSING. THE VISIBLE CHANNEL IS CALIBRATED SEPARATELY. IN OPERATION, RADIATION REFLECTS FROM THE ROTATING MIRROR TO THE COLLECTING OPTICS, A 5-IN DIAM CAS-SEGRAINIAN SYSTEM, AND IS THEN FOCUSED ONTO THE BEAM SPLITTER (DICHROIC MIRROR). THE IR PASSES THROUGH AND IS MEASURED BY A SOLID-STATE RADIANT ENERGY DETECTOR (THERMISTOR BOLOMETER). THE VISIBLE IS REFLECTED FROM THE BEAM SPLITTER AND PASSES THROUGH A 0.52-0.73 MICRON WAVELENGTH FILTER ONTO A PHOTOVOLTAIC SILICON DETECTOR. DATA ARE RECORDED ON TAPE. THE IR CHANNEL ALSO IS COMPATIBLE WITH THE APT SYSTEM PRODUCING A DIRECT READOUT IR SYSTEM.

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ENERGY IN THE INFRARED AND VISIBLE REGION OF THE SPECTRUM

### 33. MEASUREMENT RANGE

VISIBLE BRIGHTNESS: 50-10,000 FT-LAMBERTS; IR TEMP: 180-330 DEG K

### 34. PRECISION AND ACCURACY

1.0 K DEG 'AT 300 DEG K; 4.0 K DEG AT 185 DEG K

|                                       |                | Too mearnas n      | COLUTION                              | 27 TIME COME     | TANT         |
|---------------------------------------|----------------|--------------------|---------------------------------------|------------------|--------------|
| 35. SPECTRAL RANGE                    |                | 36. SPECTRAL RI    | ESOLUTION                             | 37. TIME CONS    |              |
| 0.52 TO 12.5                          |                |                    |                                       | CUNT             | INUDUS       |
| 38. FIELD OF VIEW                     | 39. GROUND SW  |                    |                                       |                  |              |
|                                       | G LIMB-TO-L    | IMB (4100          | NM) FRO                               | M 750 NM         | ALT          |
| 40. ANGULAR RESOLUTION 41. SPATIAL RI |                |                    |                                       |                  |              |
| 0.4 DEG 2 NM VIS                      | IBLE, 4 NM     | IR FROM 75         | O NM AL                               | TITUDE           |              |
| 42. POINTING ACCURACY 43. POINTING RA | TE 44. AL1     | TUDE               | 45. INCLINA                           | TION             |              |
|                                       | MED            | CIRCULAR           | SUN-SY                                | NCH RETR         | OGRADE       |
| 46. SPECIAL REQUIREMENTS              |                |                    |                                       |                  |              |
| RADIOMETERS MUST BE A                 | BLE TO SCAN    | 150 DEG W          | ITHOUT                                | OBSTRUCTI        | ONS          |
| 47. COMPONENTS                        |                |                    | <del></del>                           |                  |              |
| 2 RADIOMETER-ELECTRON                 | TCC CVCTEM     | PRICESSO           | R. TAPE                               | RECORDER         | A ANDRES CO. |
| 48. WEIGHT 49. VOLUME                 | 50 AVERAGE PON | VER 51. STANDBY PO | WER 52. PEA                           | K POWER 53.      | MTBF         |
|                                       |                |                    |                                       |                  | 1 YEAR       |
|                                       |                |                    | SHIELDING                             |                  | LILAN        |
| 54 INTERFERENCE 55 MAGNETIC 56.       |                |                    | SHIELDING                             |                  | i            |
|                                       |                | NSITIVE            | las sns                               | QUENCY OF OBSER  | VATION       |
| 59. CALIBRATION                       | 60. DATA RE    |                    |                                       |                  |              |
| 2 COLD, 1 HOT EACH SC                 | AN   DELAYED   | AND REALT          | IMEINIG                               | <u>HTTIME/DA</u> | YTIME        |
| 62. TELEMETRY REQUIREMENTS            |                |                    | <u> </u>                              |                  |              |
| BASEBAND BANDWIDTH IS                 | 7.2 KHZ.       |                    |                                       |                  | 1            |
| <u>'</u>                              |                |                    |                                       |                  |              |
| İ                                     |                |                    |                                       |                  |              |
| 63. ADVANTAGES AND LIMITATIONS        | •              |                    |                                       | =                | 1            |
| HIGHER CALIBRATION AC                 | CURACY IN V    | ISIBLE THA         | N PRESE                               | NT CAMERA        | S. NOT       |
| SUBJECT TO SHADING. P                 |                |                    |                                       |                  |              |
| 64. REFERENCES                        |                | - AND MIDIN        | , , , , , , , , , , , , , , , , , , , | ur vo kai        |              |
| 1) DESIGN STUDY REPORT                | COD THE IN     | DODVED TOS         | LITOSIS                               | VCTEW V 1        | 2.2          |
|                                       |                |                    |                                       |                  |              |
| RCA ASTRO-ELECTRONICS                 |                |                    |                                       |                  |              |
| GOLDBERG, I .: METEOROL               |                |                    |                                       | -                |              |
| SENTED AT 13TH ANNUAL                 |                |                    | TY OF P                               | HOTO-0PTI        | CAL          |
| INSTRUMENTATION ENGIN                 | EERS, AUG.     | 22, 1968.          |                                       |                  |              |
|                                       |                | mp                 |                                       |                  |              |
| 65. HISTORICAL REMARKS                |                |                    |                                       |                  | 4            |
| FLOWN ON ITOS-1                       |                |                    |                                       |                  |              |
| ·                                     |                |                    |                                       |                  |              |
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|                                | NATIONAL   | . AERO                                | NAUTICS ANI                  | D SPACE A       | DMINIST           | RATION              |             |             |                |                   |
|--------------------------------|--|---------------------------------------|------------------------------|-----------------|-------------------|---------------------|-------------|-------------|----------------|-------------------|
|                                |  |                                       | OARD SPACE F<br>GREENBELT, I |                 |                   |                     |             |             | . ,,           |                   |
| 1. TITLE                       |  |                                       |                              |                 |                   |                     | 2. ACRO     | MYM         | 3. E>          | KP NO             |
| SCANNING                       | RADIOMETER                                       |                                       |                              |                 |                   |                     | SR          |             |                |                   |
| (TITLE CONT.                   |  |                                       |                              |                 |                   |                     | 4. RESUM    | E DATE      | 5.<br><b>V</b> | ERSION            |
|                                |  |                                       |                              |                 |                   |                     | 097         | 01/7        | 72 (           | 7007              |
| 6. PRINCIPAL IN                | IVESTIGATOR                                      | 7. OR                                 | GANIZATION                   |                 |                   | 8. TELEP            |             |             |                |                   |
| GEMUNDER                       | · G. (T.MON)                                     | GOD                                   | DARD SPAC                    | EFLT            | CENTER            | 301-9               | 82-         | 5042        | 2              |                   |
| 9. CO-INVESTIG                 | ATOR   | 10. OR                                | GANIZATION                   |                 |                   | 11. TELEF           | HONE        |             |                |                   |
|                                |  |                                       |                              |                 |                   |                     |             |             |                |                   |
| 12. CONTRACT<br>TYPE           | 13. CONTRACT NUMB                                | ER                                    | 14. FLASH IND                | EX NUMBER       | 15. START<br>DATE | 16. COMPLET<br>DATE | 10N 17.     | STAT        | us             |                   |
| FP                             |  |                                       | 0                            | PERA            | TI                | JAAC                |             |             |                |                   |
| 18. MONITOR                    |  | 19. AG                                | ENCY                         | 20. PC          | M OFFICE          | 21. TELE            | PHONE       |             |                |                   |
| GARBACZ,                       | М.   | NAS                                   | A HDQTRS                     | OA <sup>c</sup> | /ERO              | 202-7               |             | 2322        | 2              | _                 |
| 22. VENDOR                     |  |                                       | 23. LOCATION                 |                 |                   | 24. F(<br>0.        | IGHT<br>ATE | 25. LI      | EAD 1          | LIME              |
| SANTA BA                       | SANTA BARBARA RES CENTER GOLETA, CALIF. 10/72 NA |                                       |                              |                 |                   |                     |             |             |                |                   |
| 26. INSTRUMEN                  |  |                                       |                              |                 |                   |                     |             |             |                | 27.<br>SECURITY   |
| RADIOMET                       | ER, VISIBLE/                                     | IR S                                  | CANNING                      |                 |                   |                     |             | -           |                | UNC               |
| 28. APPLICATIO                 | N  | · · · · · · · · · · · · · · · · · · · |                              | <b></b>         | 29. SPACE         | CRAFT               |             |             |                |                   |
| MET, ATM-PHYS, PART-FLD NOAA 2 |  |                                       |                              |                 |                   |                     |             |             |                |                   |
| 30. PURPOSE                    |  |                                       |                              |                 |                   |                     |             |             |                |                   |
| PRIMARY-                       | TO MEASURE E                                     | MITT                                  | ED RADIAT                    | ION FR          | OM THE            | EARTH               | DU          | RING        | ; D:           | AY                |
| AND NIGH                       | T AND TO MEA                                     | SURE                                  | REFLECTE                     | D RADI          | ATION             | FROM 1              | HE          | EART        | ГН             |                   |
| DURING D                       | AYTIME. THE                                      | SYST                                  | EM PERMIT                    | S DETE          | RMINAT            | ION OF              | TH          | E SU        | JRF/           | ACE               |
|                                | URE OF THE G                                     |                                       |                              |                 |                   |                     |             |             |                |                   |
| THE RADI                       |  |                                       |                              |                 |                   |                     | <del></del> | ,           |                |                   |
|                                |  |                                       |                              |                 |                   |                     |             |             |                |                   |
| 31. PRINCIPLES                 | OF OPERATION                                     |                                       |                              |                 |                   |                     |             |             |                |                   |
| THIS SCA                       | NNING RADIOM                                     | ETER                                  | SYSTEM C                     | ONSIST          | S OF 2            | REDUN               | DAN         | TRA         | DI             | )M-               |
| ETERS WI                       | TH SUPPORTIN                                     | G CO                                  | MPONENTS.                    | EACH            | HAS 2.            | DATA                | HAN         | NELS        | S :            | AN                |
|                                | -12.5 MICRON                                     |                                       |                              |                 |                   |                     |             | BOTH        |                | I TH              |
|                                | NTANEOUS FOV                                     |                                       |                              |                 |                   |                     |             | THE         |                |                   |
| 1                              | SURFACE FROM                                     |                                       |                              |                 |                   |                     | -           |             | THE            | =                 |
|                                | PLANE BY MEA                                     |                                       |                              |                 |                   |                     |             |             |                |                   |
|                                | INCLINED 45                                      |                                       |                              |                 |                   |                     | THE         | ĪR          |                |                   |
|                                | ALIBRATED AT                                     |                                       |                              |                 |                   |                     |             | -           | _              |                   |
|                                | SPACE AND O                                      |                                       |                              |                 |                   |                     |             |             |                |                   |
|                                | M INSIDE THE                                     |                                       |                              |                 |                   |                     |             |             |                |                   |
| CALTERAT                       | ED SEPARATEL                                     | Y.                                    | IN OPERAT                    | TON P           | ANTATE            | UNI DEE             | LEC         | TCE         | 14 E           | 4                 |
|                                | TING MIRROR                                      |                                       |                              |                 |                   |                     |             |             |                |                   |
|                                | AN SYSTEM, A                                     |                                       |                              |                 |                   |                     |             |             |                |                   |
|                                | C MIRROR). T                                     |                                       |                              |                 |                   |                     |             |             |                |                   |
| SOL TO-ST                      | ATE RADIANT                                      | ENED                                  | N FM33E3<br>CV netert        | OD ITH          | II ANU<br>Edmict  | אסוי כו<br>מס פטי   | UNE:        | EU D        | ) T            | 4<br><b>7</b> 11/ |
| VICIBLE                        | IS REFLECTED                                     | EDU                                   | M THE DEA                    | M CDIT          | EKMISI            | UK DUL              | UME.        | TUO         |                | IME               |
| A 0.52-0                       | .72 MICDON W                                     | I'RU:<br>Avei                         | M IME DEA                    | TED ON          | TO A C            | NU PAS              | ) E 3       | 1714        | UU             | יים<br>זו         |
| DETECTO                        | .73 MICRON W                                     | EC OD                                 | CNUIT TIL                    | JEK UN          | IU A PI           | 70 I U V L          | LIA         | 16 5        | ILI            | LUUN              |
|                                | • DATA ARE R                                     |                                       |                              |                 |                   |                     |             |             |                |                   |
| SYSTEM.                        | LE WITH THE                                      |                                       |                              | UDUCIN          | G A DI            | KECT R              | EAD         | JUT         | ΙK             |                   |
|                                |  |                                       |                              | •               |                   |                     |             | **          |                |                   |
| 32. PHENOMEN                   |  | <u> </u>                              | ND VICIO                     | <u> </u>        | <u> </u>          | T                   |             | 2 1 1 1 1   |                | <u>,,</u>         |
|                                | THE INFRAR                                       | EU A                                  | MD A121RF                    | E KEGI          | UN UF             | THE SP              | ECT         | KUM         |                |                   |
| 33. MEASUREM                   |  | FA :                                  |                              |                 | T.O               |                     |             |             |                |                   |
| ATSTREE                        | BRIGHTNESS:                                      |                                       | U,000 FT-                    | LAMBER          | 15; IR            | TEMP:               | 180-        | <u>-330</u> | <u>DE</u>      | <u> :G K</u>      |

1.0 K DEG AT 300 DEG K; 4.0 K DEG AT 185 DEG K

| 35. SPECTRAL RANGE                      |  |             | 36. SPECTRA                             | AL RESOLU     | TION             | 37. TIME                              | CONSTAN       | Γ        |
|---|--|-------------|---|---------------|------------------|---------------------------------------|---------------|----------|
| 0.52 TO                                 |  | ICRONS      |   |               |                  |                                       | ONTIN         | JOUS     |
| 38. FIELD OF VIEW                       |  | OUND SWA    |   |               |                  |                                       | A114 A4 4     | <u> </u> |
| 150.0<br>40. ANGULAR RESOLUTION 41. SPA | DEG LIMI   |             | IMB (41                                 | 00_NM)        | FRO              | M (50                                 | NM AL         |          |
| <u> </u>                                | VISIBLE,   |             | ID EDOM                                 | 750 N         | M AI             | TITUDE                                |               |          |
| 42. POINTING ACCURACY 43. POIN          |  | 44. ALTI    |   |               | NCLINA           |                                       |               |          |
|   |  | MED         | CIRCUL                                  | AR SU         | N-SY             | VCH P                                 | ETROGE        | RADE     |
| 46. SPECIAL REQUIREMENTS                |  |             |   |               |                  |                                       |               | j        |
| RADIOMETERS MUST                        | BE ABLE TO   | SCAN        | 150 DE                                  | G WITH        | OUT              | JBSTRL                                | ICTION!       | 5        |
| 47. COMPONENTS                          | AND THE CONTRACTOR OF THE CONT | V           | ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, |               |                  |                                       |               |          |
| 2 RADIOMETER-ELEC                       |  |             |   |               |                  |                                       |               |          |
| 48. WEIGHT 49. VOLUME                   |  |             | R 51. STAND                             | BY POWER      | 52. PEA          | KPUWER                                | 53. MTBI      |          |
| 40 LB 0.5                               | CU FT  | 157T        | HERMAL<br>RFERENCE                      | 58. SHIEL     | DING             | <u></u>                               | <u>ا السل</u> | (EAR     |
| **INTERFERENCE INTERFERENCE             | INTERFERENCE   | <del></del> | VSITIVE                                 |               | <del>5.110</del> |                                       |               |          |
| 59. CALIBRATION                         | 60.  | DATA REC    |   | <u> </u>      | 61. FRE          | QUENCY OF                             | OBSERVATIO    | N        |
| 2 COLD. 1 HOT EAC                       |  |             | AND RE                                  | ALTIME        | NIG              | HTTLME                                | /DAYT         | LME      |
| 62. TELEMETRY REQUIREMEN                |  |             |   |               |                  |                                       |               | 12°.     |
| BASEBAND BANDWIDT                       | H IS 7.2 H   | CHZ.        |   |               |                  |                                       |               |          |
|   |  |             |   |               |                  |                                       |               |          |
| 63. ADVANTAGES AND LIMITA               | TIONS  |             | <del> </del>                            | <del></del>   |                  |                                       |               |          |
|   |  |             |   |               |                  | . =                                   |               |          |
| HIGHER CALIBRATIC                       |  |             |   |               |                  |                                       | -             | NUT      |
| SUBJECT TO SHADIN 64. REFERENCES        | G. PRUVIDE   | -S DAY      | AND NI                                  | GHI KE        | ALILI            | 1F IK                                 | DAIA          |          |
| 1)DESIGN STUDY RE                       | POPT FOR 1   | THE TM      | PROVED '                                | TOSLIT        | 05151            | CTEM.                                 | V.1.2.        | 3.       |
| RCA ASTRO-ELECTRO                       | The second secon |             |   |               |                  |                                       |               |          |
| GOLDBERG.I.: METE                       | =  |             |   |               | •                | -                                     |               |          |
| SENTED AT 13TH AN                       |  |             |   |               |                  |                                       |               |          |
| INSTRUMENTATION E                       | NGINEERS.  | AUG.        | 22, 196                                 | 8.            |                  |                                       |               |          |
| 25 1107071011 051410140                 |  |             |   | · <del></del> |                  |                                       |               |          |
| 65. HISTORICAL REMARKS                  |  |             |   |               |                  | · · · · · · · · · · · · · · · · · · · |               |          |
| FLOWN ON NOAA-1                         | ND ITOS-1  |             |   |               |                  |                                       |               |          |
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### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771

1. TITLE 2. ACRONYM 3. EXP NO TEMPERATURE/HUMIDITY INFRARED RADIOMETER THIR (TITLE CONT.) 4. RESUME DATE VERSION 09/01/72/0007 6. PRINCIPAL INVESTIGATOR 7. ORGANIZATION 8. TELEPHONE GODDARD SPACE FLT CENTER 301-982-5042 MC CULLOCH, A. W. 10. ORGANIZATION 11. TELEPHONE 9. CO-INVESTIGATOR GODDARD SPACE FLT CENTER 301-982-5042 GOLDBERG, I. L. 16. COMPLETION 17. STATUS 12. CONTRACT 13. CONTRACT NUMBER 14. FLASH INDEX NUMBER OPERATIONAL 19. AGENCY 20. PGM OFFICE 18. MONITOR 21. TELEPHONE NASA HDQTRS SCHARDT, B.B. OA/ERN 202-755-2322 22. VENDOR 23. LOCATION 24. FLIGHT 25. LEAD TIME SANTA BARBARA RES. CORP. SANTA BARBARA, CALIF. 04/70 NA 26. INSTRUMENT TYPE ECURITY RADIOMETER, 2-CHANNEL IR HIGH-RESOLUTION SCANNING UNC 28. APPLICATION 29. SPACECRAFT MET, ERSP NIMBUS-4

30. PURPOSE

PRIMARY-TO PROVIDE NIGHT AND DAY TIME RESOLUTION, IR TEMPERATURE MAPS OF CLOUDS, LAND, AND OCEAN SURFACE OF THE EARTH.\*\*\*SECON-DARY- TO PROVIDE SYNOPTIC HUMIDITY PATTERNS. TO TRY TO TRACE AIR MASS BOUNDARIES, VERTICAL MOTIONS AND JET STREAMS.\*\*\*TERTIARY-TO PROVIDE SUPPORTING DATA FOR OTHER EXPERIMENTERS.

### 31. PRINCIPLES OF OPERATION

THIS RADIOMETER LIKE THE HRIR IS A SCANNING RADIOMETER. THE SCAN IS ACCOMPLISHED BY A PLANE MIRROR ROTATING AT 48 RPM. RADIATION FROM THE SCANNING MIRROR IS COLLECTED AND FOCUSED BY A CASSE-GRAINIAN TELESCOPE WITH A 5 INCH PRIMARY MIRROR. A DICHROIC BEAM SPLITTER AND FILTERS THEN DIVIDE THE BEAM INTO 2 CHANNELS, A 6.5-7.0 MICRON CHANNEL FOR WATER VAPOR MEASUREMENTS AND A 10.5-12.5 MICRON CHANNEL FOR SURFACE OR CLOUD TOP TEMPERATURE MEA-SUREMENTS. IMMERSED THERMISTOR BOLOMETERS ARE THE DETECTORS IN BOTH CHANNELS. DURING A SCAN PERIOD OF 1.25 SEC, THERE IS A SYNC SIGNAL, A STEPPED VOLTAGE CALIBRATION SIGNAL, A SCAN OF COLD SPACE FOR A ZERO LEVEL, THE SCAN OF EARTH, ANOTHER SPACE SCAN, AND A HOUSING SCAN TO GIVE A WARM BODY CALIBRATION POINT. THERE IS NO RADIATION CHOPPING IN THIS INSTRUMENT. THE SWEEP RATE AND THE FIELD OF VIEW ARE CHOSEN SO THAT CONTIGUOUS SCANNING OCCURS ALONG THE SUBSATELLITE TRACK WITH INCREASING OVERLAP TOWARD THE HORIZON. THE 11 MICRON CHANNEL HAS A 0.4 DEG (7.0 MILLIRAD) FOV WHICH GIVES A 4.2 NM RESOLUTION FROM A 600 NM ORBIT. THE 6-MICRON CHANNEL HAS A 1.2 DEGREE (21 MILLIRADIANS) FIELD OF VIEW GIVING A 12.6 NM RESOLUTION FROM A 600 NM ORBIT.

### 32. PHENOMENA OBSERVED

IR RADIATION FROM THE EARTH'S SURFACE AND CLOUDS

### 33. MEASUREMENT RANGE

185 TO 300 DEG KELVIN

### 34. PRECISION AND ACCURACY

+-7 K DEG

| 35. SPECTRAL RANGE                               | · · · · · · · · · · · · · · · · · · · | 36. SPECTRAL RESOL           | UTION 37. TIME CONSTANT               |
|--|---------------------------------------|------------------------------|---------------------------------------|
| 6.5 10 12.5                                      | MICRUNS                               | SEE ITEM 31                  | 3.15SECONDS                           |
| 38. FIELD OF VIEW                                | 39. GROUND SWA                        |                              |                                       |
| SEE ITEM 31                                      | l                                     | MR (3800 NW)                 | FRUM 600 NM ALT                       |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES           |                                       |                              |                                       |
| SEE ITEM 31 SEE ITEM                             |                                       |                              |                                       |
| 42. POINTING ACCURACY 43. POINTING RATI          |                                       |                              | INCLINATION N-SYNCH RETROGRADE        |
| 1.0 DEG  | ואכט                                  | CIRCULAR 30                  | N- 3 NCH RETROGRADE                   |
| 46. SPECIAL REQUIREMENTS DETECTOR TEMPEMPERATURE | - SHALL NO                            | EXCEED +40                   | DEG C.                                |
| 47. COMPONENTS                                   |                                       |                              |                                       |
| INTERFERENCE FILTER RAT                          | DIOMETER, E                           | LECTRONICS,                  | MIRRORS, TELESCOPE                    |
| 48. WEIGHT 49. VOLUME                            | 50. AVERAGE POW                       |                              |                                       |
| 20 LB 0.5 CU FT                                  | 9 WAT                                 | S                            |                                       |
| 54. INTERFERENCE 55. INTERFERENCE 56. INTE       | UCLEAR 57. INT                        | HERMAL<br>ERFERENCE 58. SHIE | LDING                                 |
| ı  | SEI                                   | AZITIVE                      |                                       |
| 59. CALIBRATION                                  | 60. DATA REC                          |                              | 61. FREQUENCY OF OBSERVATION          |
| BLK BODY AND COLD SPACE                          | DELAYED                               | AND REALTIME                 | CONTINUOS                             |
| 62. TELEMETRY REQUIREMENTS                       | NECESTED.                             |                              |                                       |
| 630 HZ INFORMATION BANK                          | חוטוש                                 |                              |                                       |
|  |                                       |                              |                                       |
| 63. ADVANTAGES AND LIMITATIONS                   |                                       |                              |                                       |
| BETTER S/N THAN HRIR.                            | AN GIVE C                             | TRRUS CLOUD C                | UNTENT: LIMITED TO                    |
| CLOUD-TOP DATA                                   |                                       |                              |                                       |
| 64. REFERENCES                                   | ·····                                 | •                            |                                       |
| I) KAHN, W.: THIR SUBSY                          | STEM DIREC                            | TURY (PRELIM                 | 1. GENERAL ELECTRIC                   |
| CO., NOV. 1967.***2)GDL                          | DBERG, I.                             | , METEOROLO                  | GICAL INFRARED                        |
| INSTRUMENTS FOR SATELL!                          | ITES. GIVE                            | N AT 13TH ANN                | UAL TECH. SYMP. OF                    |
| SOC.PHOTO-OPTICAL ENGR.                          |                                       | ·                            | IMBUS D EXPERIMENT-                   |
| ER PROGRAM REVIEW. 25-2                          | 26 OCT. 190                           | <b>67.</b>                   |                                       |
|  |                                       |                              |                                       |
| 65. HISTORICAL REMARKS                           | ·····                                 |                              | · · · · · · · · · · · · · · · · · · · |
| SIMILAR TO HRIR                                  | ·                                     |                              |                                       |
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| 1. TITLE          |                  |        |                                      |             |                   |                  | 2. 4              | CRONYM     | 3. E | XP NO           |
|-------------------|------------------|--------|--------------------------------------|-------------|-------------------|------------------|-------------------|------------|------|-----------------|
| TEMPERATU         | RE/HUMIDITY      | INF    | RARED RADIOME                        | TER         | }                 |                  | T⊦                | IIR        |      |                 |
| (TITLE CONT.)     |                  |        |                                      |             |                   |                  | 4 R               | ESUME DATE | T    | 5.<br>VERSION   |
|                   |                  |        |                                      |             |                   |                  | 05                | 7017       |      |                 |
| 6. PRINCIPAL IN   | VESTIGATOR       | 7. OR  | GANIZATION                           |             |                   | 8. TI            | ELEPHO            | NE         |      |                 |
| MC CULLOC         | H, A. W.         | GODI   | ODDARD SPACE FLT CENTER 301-982-5042 |             |                   |                  |                   |            |      |                 |
| 9. CO-INVESTIGA   | TOR              | 10. OR | GANIZATION                           |             |                   | 11. T            | ELEPHO            | NE         |      |                 |
| GOLDBERG,         | I. L.            | GODI   | DARD SPACE FL                        | T C         |                   | 30               | 1-982             | -5042      | 2    |                 |
| 12. CONTRACT TYPE | 3. CONTRACT NUMB | ER     | 14. FLASH INDEX NUI                  | <b>VBER</b> | 15. START<br>DATE | 16. <sup>C</sup> | OMPLETION<br>DATE | 17. STAT   | ับร  |                 |
|                   |                  |        |                                      |             |                   |                  |                   | OPERA      | TI   | ONAL            |
| 18. MONITOR       |                  | 19. AG | ENCY                                 | 20. PG      | M OFFICE          | 21. T            | ELEPHO            | NE         |      |                 |
| SCHARDT,          | 8.8.             | NAS    | A HDQTRS                             | OA/         | 'ERN              | 20               | 2-755             | -2322      | 2    |                 |
| 22. VENDOR        |                  |        | 23. LOCATION                         |             |                   |                  | 24 FLIGHT<br>DATE | 25. L      | EAD  | TIME            |
| SANTA BAR         | BARA RES. CO     | ORP.   | SANTA BARBAR                         | ξД,         | CALIF             |                  | 12/7              | 2 NA       |      |                 |
| 26. INSTRUMENT    | TYPE             |        |                                      |             |                   |                  |                   |            |      | 27.<br>SECURITY |
| RADIOMETE         | R, 2-CHANNEL     | IR     | HIGH-RESOLUT                         | ION         | SCAN              | VIN(             | 3                 |            |      | UNC             |
| 28. APPLICATION   |                  |        |                                      |             | 29. SPACEO        | CRAF             | T                 |            |      |                 |
| MET, ERSP         |                  | •      |                                      |             | NIMBUS            | S-E              |                   |            |      |                 |
| 30. PURPOSE       |                  |        |                                      |             |                   |                  |                   |            |      |                 |
|                   |                  |        |                                      |             |                   |                  |                   |            |      |                 |

PRIMARY-TO PROVIDE NIGHT TIME AND DAY TIME INFRARED TEMPERATURE MAPS OF CLOUDS, LAND, AND OCEAN SURFACE OF THE EARTH.\*\*\*SECON-DARY- TO PROVIDE SYNOPTIC HUMIDITY PATTERNS. TO TRY TO TRACE AIR MASS BOUNDARIES, VERTICAL MOTIONS AND JET STREAMS.\*\*\*TERTIARY-TO PROVIDE SUPPORTING DATA FOR OTHER EXPERIMENTERS.

### 31. PRINCIPLES OF OPERATION

THIS RADIOMETER AS THE HRIR IS A SCANNING RADIOMETER. THE SCAN IS ACCOMPLISHED BY A PLANE MIRROR ROTATING AT 48RPM. REFLECTIONS FROM THE SCANNING MIRROR IS COLLECTED AND FOCUSED BY A CASSE-GRAINIAN TELESCOPE WITH A 5 INCH PRIMARY MIRROR. A DICHROIC BEAM SPLITTER AND FILTERS THEN DIVIDE THE BEAM INTO 2 CHANNELS, A 6.5-7.0 MICRON CHANNEL FOR WATER VAPOR MEASUREMENTS AND A 10.5-12.5 MICRON CHANNEL FOR SURFACE OR CLOUD TOP TEMPERATURE MEA-SUREMENTS. IMMERSED THERMISTOR BOLOMETERS ARE THE DETECTORS IN BOTH CHANNELS. DURING A SCAN PERIOD OF 1.25 SEC, THERE IS A SYNC SIGNAL, A STEPPED VOLTAGE CALIBRATION SIGNAL, A SCAN OF COLD SPACE FOR A ZERO LEVEL, THE SCAN OF EARTH, ANOTHER SPACE SCAN, AND A HOUSING SCAN TO GIVE A WARM BODY CALIBRATION POINT. THERE IS NO RADIATION CHOPPING IN THIS INSTRUMENT. THE SWEEP RATE AND THE FIELD OF VIEW ARE CHOSEN SO THAT CONTIGUOUS SCANNING OCCURS ALONG THE SUBSATELLITE TRACK WITH INCREASING OVERLAP TOWARD THE HORIZON FOR THE 11-MICRON CHANNEL. ELEVEN MICRON HAS A 0.4 DEG (7.0 MILLIRAD) FOV WHICH GIVES A 4.2 NM RESOLUTION FROM A 600 NM ORBIT. THE 6-MIVRON CHANNEL HAS A 1.2 DEG (21 MILLIRAD) FOV GIVING A 12.6 NM RESOLUTION FROM A 600 NM ORBIT.

### 32. PHENOMENA OBSERVED

IR RADIATION FROM THE EARTH'S SURFACE AND CLOUDS

### 33. MEASUREMENT RANGE

185 TO 300 DEG KELVIN

34. PRECISION AND ACCURACY

+-7 DEG K

|                                       | •  |  |
|---------------------------------------|--|--|
| 35. SPECTRAL RANGE                    | 36. SPECTRAL RESOLUT                       |  |
| 6.5 TO 12.5                           |  | SEE ITEM 62  |
| 38. FIELD OF VIEW                     | 39. GROUND SWATH                           | FOOM / SA NIN AL Y   |
| SEE ITEM 31                           | LIMB-TO-LIMB (3800 NM)                     | FRUM 600 NM ALI  |
| 40. ANGULAR RESOLUTION 41. SPATIAL RE |  |  |
| SEE ITEM 31   SEE ITEM                |  |  |
| 42. POINTING ACCURACY 43. POINTING RA |  | STATES ST |
| 1. DEG                                | MED C INCOLAR   SON                        | -STACH HIGH AUGN   |
| 46. SPECIAL REQUIREMENTS              | RE SHALL NOT EXCEED +40 D                  | FC C.  |
| 47. COMPONENTS                        | TE STIALE NOT EXCLED 140 D                 |  |
| 1                                     | ADIOMETER, ELECTRONICS, M                  | TRROPS. TELESCOPE  |
| 48. WEIGHT 49. VOLUME                 | 50. AVERAGE POWER   51. STANDBY POWER   52 | <del></del>  |
| 20 LB 0.5 CU                          |  | 30, 11721  |
|                                       | NUCLEAR ST. THERMAL SB. SHIELD             | ING  |
| INTERPERENCE INTERPERENCE II          | SENSITIVE                                  |  |
| 59. CALIBRATION                       |  | 1. FREQUENCY OF OBSERVATION  |
| BLK BODY AND COLD SPA                 | CE DELAYED TELEMETRY                       | CONTINUOUS   |
| 62. TELEMETRY REQUIREMENTS            |  |  |
| 130 HZ FOR 6.5-7.0 MI                 | CRON CHANNEL: 345 HZ FOR                   | 10.5-12.5 MICRONS  |
|                                       |  |  |
|                                       |  |  |
| 63. ADVANTAGES AND LIMITATIONS        |  |  |
| BETTER S/N THAN HRIR,                 | CAN GIVE CIRRUS CLOUD CO                   | NTENT; LIMITED TO  |
| CLOUD-TOP DATA                        |  | ,  |
| 64. REFERENCES                        | ς  |  |
| 1) KAHN, W.: THIR SUB                 | SYSTEM DIRECTORY (PRELIM)                  | . GENERAL ELECTRIC   |
| 1                                     | OLDBERG, I.L., METEOROLDG                  | •  |
|                                       | ITES. GIVEN AT 13TH ANNU                   |  |
|                                       | R., AUG 19-23, 1968. ***31NI               | _  |
| ER PROGRAM REVIEW, 25                 |  |  |
| ď                                     |  |  |
| 65. HISTORICAL REMARKS                |  |  |
| SIMILAR TO HRIR                       |  |  |
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### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER

| GREENBELT, MD. 207 |
|--------------------|
|--------------------|

| 1. TITLE             |                  |         |                                       |               |           |       | 2. /               | ACRONYM              | 3. € | XP NO           |  |
|----------------------|------------------|---------|---------------------------------------|---------------|-----------|-------|--------------------|----------------------|------|-----------------|--|
| TWO-CHAN             | NEL RADIOMET     | ER      |                                       |               |           |       | T                  | R                    |      |                 |  |
| (TITLE CONT.         | )                |         |                                       |               |           |       | 4. R               | ESUME DATE           |      | 5.<br>VERSION   |  |
|                      |                  |         |                                       |               |           |       | 100                | 7017                 | 72]  | 0002            |  |
| 6. PRINCIPAL II      | NVESTIGATOR      | 7. OR   | GANIZATION                            | LEPHO         | PHONE     |       |                    |                      |      |                 |  |
|                      |                  |         |                                       |               |           |       |                    |                      |      | -               |  |
| 9. CO-INVESTIG       | ATOR             | 10. OR  | GANIZATION                            |               |           | 11. T | ELEPHO             | EPHONE               |      |                 |  |
|                      |                  |         |                                       |               |           |       |                    |                      |      |                 |  |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUM | BER     | 14. FLASH INDEX NUMBER 15. START DATE |               |           |       | DAPLETION<br>DATE  | 17. STA              | rus  |                 |  |
|                      |                  |         |                                       |               | Ì         |       |                    | PROP                 | OSA  | L               |  |
| 18. MONITOR          |                  | 19. AG  | ENCY                                  | 21. TELEPHONE |           |       |                    |                      |      |                 |  |
| SCHARDT,             | B.B.             | NAS     | A HDQTRS                              | DA            | 'ERN      | 20    | 2-75               | 5-232                | 2    |                 |  |
| 22. VENDOR           |                  | •       | 23. LOCATION                          |               |           |       | 24. FLIGHT<br>DATE | FLIGHT 25. LEAD TIME |      |                 |  |
|                      |                  |         |                                       |               | - '       |       | 19                 | 74                   |      | ,               |  |
| 26. INSTRUMEN        | IT TYPE          |         |                                       |               |           |       |                    |                      |      | 27.<br>SECURITY |  |
| RADIOMET             | ER, IR           |         |                                       |               |           |       |                    |                      |      | UNC             |  |
| 28. APPLICATIO       | N                |         |                                       |               | 29. SPACE | CRAF  | T                  |                      |      |                 |  |
| MET, ERS             | Р                |         |                                       |               | NIMBU     | S-F   |                    |                      |      |                 |  |
| 30. PURPOSE          |                  |         |                                       |               |           |       |                    |                      |      |                 |  |
| 00 7 11 4 0 14       | TO DETECT TO     | C D M A | A DADTATION                           | 75            | THE EA    | DTIL  | A AID              | ATMO                 | C 01 | C 0.C           |  |

PRIMARY-TO DETECT THERMAL RADIATION OF THE EARTH AND ATMOSPHERE \*\*\*SECONDARY-TO PRODUCE HIGH RESOLUTION INFRARED CLOUD COVER **PICTURES** 

### 31. PRINCIPLES OF OPERATION

THE INSTRUMENT USES A SCANNING TWO-CHANNEL RADIOMETER TO INTER-CEPT RADIATION IN LATERAL STRIPS FROM HORIZON-TO-HORIZON TO FORM CONTINUOUS HIGH RESOLUTION SCENES. THE WATER-VAPOR CHANNEL IS 6.5 TO 7.0 MICRONS AND THE CO2 CHANNEL IS 10.5 TO 12.5 MICRONS-BOTH CHANNELS WILL HAVE 24-HOUR VIEWING CAPABILITY. A COMBINA-TION MIRROR-TELESCOPE IMAGING SYSTEM WILL TRANSMIT EARTH AND CLOUD TOP RADIATION TO BOLOMETER DETECTORS AND WILL ALSO VIEW SPACE AND THE INSTRUMENT FRAME FOR CALIBRATION REFERENCES DURING THE SCANNING PERIOD. THE RADIOMETER EMPLOYS A 5-INCH FOLDED OPTICAL SYSTEM AND A SCANNING MIRROR COMMON TO BOTH CHANNELS. THE GROUND RESOLUTION IS EXPECTED TO BE 4.2 NAUTICAL MILES IN THE 10.5 TO 12.5 MICRON REGION AND ABOUT 12.6 NAUTICAL MILE IN THE 6.5 TO 7.0 MICRON BAND FROM ORBIT.

### 32. PHENOMENA OBSERVED

RADIATION FROM EARTH AND CLOUD TOPS

### 33. MEASUREMENT RANGE

THERMAL REGION

34. PRECISION AND ACCURACY

SEE ITEM 31



| 35. SPECTRAL     | RANG    | E .  |         | ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, | W/ 1.000            | 36.               | SPECTRA   | L RE   | SOLU                                  | TION    | 37. TIME  | CONSTANT    |
|------------------|---------|--|---------|---|---------------------|-------------------|-----------|--------|---------------------------------------|---------|-----------|-------------|
| 6.5              |         | ro 12  | • 5     | MIC                                     | RONS                | SE                | EITE      | M :    | 31                                    |         |           |             |
| 38. FIELD OF     |         |  |         |   | UND SW              |                   |           |        |                                       |         |           |             |
| 0.4              | BY      | AND 1.2  | DEG     | 4.2 8                                   | 12.                 | 6 N               | M HOI     | 21Z    | 0N-1                                  | 0-H     | DRIZON    |             |
| 40. ANGULAR RE   | SOLUTIO | N 41. SPATIA   | L RESO  | LUTION                                  |                     |                   |           |        |                                       |         |           |             |
|                  |         |  |         |   |                     |                   |           |        |                                       |         |           |             |
| 42. POINTING AC  | CURACY  | 43. POINTING   | RATE    |   | 44. ALT             | ITUD              | E         |        |                                       | CLINA   |           |             |
|                  |         |  |         |   | MED                 | CI                | RCULA     | 1R     | SUN                                   | 1-24    | VCH RE    | TRUGRADE    |
| 46. SPECIAL I    | REQUIR  | EMENTS   |         |   |                     |                   |           |        |                                       |         |           |             |
|                  | -       |  |         |   |                     |                   | - 5%      |        |                                       |         |           |             |
| 47. COMPONE      | NTS     | Tall I have a new management   |         | 1   2000   100   2000                   |                     | as Noticean Train |           |        |                                       | T       |           |             |
| IR RADI          | OMETI   | ER, OPTI   | CS &    | SCAN                                    | INING               | MI                | RROR      | , DE   | ETEC                                  | TOR     | S, ELE    | CTRUNICS    |
| 48. WEIGHT       | 49. V   | OLUME  | -       | 50. AVE                                 | RAGE POW            | ER                | 51. STAND | BY POV | NER 5                                 | 2. PEA  | K POWER   | 53. MTBF    |
|                  |         | a second cold account of Association and Assoc |         |   |                     |                   |           |        |                                       |         |           |             |
| 54. INTERFERENCE | 55.     | MAGNETIC<br>NTERFERENCE  | 56. NUC | LEAR<br>FERENCE                         | 57. <sub>(N</sub> 1 | THERMA            | L<br>NCE  | 58. S  | HIELI                                 | DING    |           |             |
|                  |         | 1 100000   |         |   |                     |                   | TIVE      |        |                                       |         |           |             |
| 59. CALIBRAT     | TION    |  |         | 60. D                                   | ATA RE              |                   |           |        | , ]                                   | 61. FRE | QUENCY OF | DBSERVATION |
|                  |         |  |         |   |                     |                   |           |        |                                       | CON     | TINUOU    | S           |
| 62. TELEMET      | RY REC  | UIREMENTS  |         | <b>_</b>                                |                     |                   |           |        | · · · · · · · · · · · · · · · · · · · |         |           |             |
|                  | -       |  |         |   |                     |                   |           |        |                                       |         |           |             |
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|                  |         |  |         |   |                     |                   |           |        |                                       |         |           |             |
| 63 ADVANTA       | GES A   | ND LIMITATIO   | NS      |   |                     |                   |           |        |                                       |         |           |             |
| 03. ADVANTA      | IGES AI | TO EIMITATIO   | 143     |   |                     |                   |           |        |                                       | _       |           |             |
|                  |         |  |         |   |                     |                   |           |        |                                       |         |           |             |
| or percorn       | ore -   |  |         | - 1:                                    |                     | ····              |           |        |                                       |         | , a       |             |
| 64. REFEREN      |         | 5171 611   |         | <del></del>                             | 1 7 44 5 1 1        |                   |           | , .    |                                       |         | ·         |             |
| LEKELIMI         | NAKY    | DATA SH  | FF1.    | FUK I                                   | AIMBO               | 2-1               | • NU      | V • 1  | 19                                    | U       |           |             |
|                  |         |  |         |   |                     |                   |           |        |                                       |         |           |             |
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| 1                |         |  |         |   |                     |                   |           |        |                                       |         |           |             |
|                  |         | · · · · · · · · · · · · · · · · · · ·  |         |   |                     |                   |           |        |                                       |         |           |             |
| 65. HISTORIC     | AL REN  | MARKS  |         |   |                     |                   | •         |        |                                       |         |           |             |
|                  |         |  |         |   |                     |                   |           |        |                                       |         |           |             |
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|                  |         |  |         |   |                     |                   |           |        |                                       |         |           |             |

GREENBELT, MD. 20771 1. TITLE 2. ACRONYM 3. EXP NO VTPRVERTICAL TEMPERATURE PROFILE RADIOMETER 09/01/72 0001 (TITLE CONT.) 8. TELEPHONE 6. PRINCIPAL INVESTIGATOR 7. ORGANIZATION 301-982-5042 NASA/GSFC R. PINAMONTI 10. ORGANIZATION 11. TELEPHONE 9. CO-INVESTIGATOR 15. START 16. COMPLETION 17. STATUS 12. CONTRACT 13. CONTRACT NUMBER 14. FLASH INDEX NUMBER **OPERATIONAL** 19. AGENCY 20. PGM OFFICE 21. TELEPHONE 18. MONITOR 202-755-2322 OA/ERO NASA HDOTRS

GARBACZ, M NASA HDQTRS OA/ERO 202-/55-2322

22. VENDOR 23. LOCATION 24 GLIGHT 25. LEAD TIME
BARNES ENGINEERING STAMFORD, CONN. LO/72

26. INSTRUMENT TYPE
RADIOMETER
UNC

28. APPLICATION 29. SPACECRAFT MET, ATM-PHYS NOAA-2

### 30. PURPOSE

PRIMARY- TO OBTAIN A CONTINUOUS SERIES OF WORLD-WIDE REAL-TIME IOSTHERM MAPS AT ALTITUDES UP TO 30KM. VERTICAL TEMPERATURE PROFILES ARE DERIVED FROM RADIOMETRIC MEASUREMENTS IN EIGHT CHANNELS THROUGH MATHEMATICAL INVERSION TECHNIQUES.

### 31. PRINCIPLES OF OPERATION

RADIANT ENERGY IN EIGHT OPTICAL FILTER CHANNELS, 6 IN THE 15 MICRON CO2 BAND, ONE IN THE 8-12 MICRON WINDOW AND ONE IN THE 18.7 MICRON H20 BAND, IS COLLECTED FROM THE 2.2° X 2.1° FIELD OF VIEW BY A CASSEGRAIN TYPE OPTICAL SYSTEM USING SPHERICAL SUR-FACES ON THE PRIMARY AND SECONDARY MIRRORS. THESE TWO ELEMENTS PRODUCE AN F/3 CONVERGING OPTICAL BEAM ONTO THE ROTATING FILTER WHEEL AT WHICH POINT THE FIELD DEFINING STOPS ARE SITUATED. AFTER PASSING THROUGH THIS FIELD STOP, THE ENERGY IS FOCUSED ONTO A PYROELECTRIC DETECTOR CELL BY A FIELD OPTICAL SYSTEM IRTRAN-4 FIELD LENS AND A REFLECTIVE PYRAMID COMPRISED OF OPTIC. THE DETECTOR IS SITUATED AT THE TRUNCATED OPENING OF THE REFLECTIVE PYRAMID WHICH PRODUCES AN ESSENTIALLY CIRCULAR IMAGE POLYHEDRON. THIS IMAGE POLYHEDRON EFFECTIVELY MAGNIFIES THE DE-TECTOR AREA AND RESULTS IN AN EFFECTIVE OPTICAL SPEED FOR THE INSTRUMENT OF F/O.6.CROSSTRACK SCANNING IS ACHIEVED THROUGH THE USE OF A STEPPER MOTOR AND CAM, WHICH IN TURN CAUSES THE SCAN MIRROR TO MOVE ABOUT AN AXIS NORMAL TO THE OPTICAL AXIS OF THE VTPR TELESCOPE. FOR IN-FLIGHT CALIBRATION, IT IS NECESSARY TO MOVE THE SCAN MIRROR ABOUT THE OPTICAL AXIS OF THE TELESCOPE.

# 32. PHENOMENA OBSERVED ENERGY IN THE INFRARED REGION OF THE SPECTRUM 33. MEASUREMENT RANGE 34. PRECISION AND ACCURACY 0.6 DEG AT 300 DEG K

| 35. SPECTRAL      | RANGE                        |            | #1.        | 3                                     | 6. SPECTRA     | AL RES      | SOLUTION                              | 37. TIME   | CONSTANT      |
|-------------------|------------------------------|------------|------------|---------------------------------------|----------------|-------------|---------------------------------------|--|---------------|
| 8 TO 18.          | .7 MICRONS                   |            |            |                                       | V.             |             |                                       | 0.5  | SEC           |
| 38. FIELD OF V    | 'IEW                         | 39.        | GROUNE     | SWAT                                  | Η              |             |                                       |  |               |
| 2.2° BY           |                              |            |            |                                       |                |             |                                       |  |               |
| 40. ANGULAR RES   | OLUTION 41. SPATIAL          | L RESOLU   | ITION      |                                       |                |             |                                       |  |               |
| 40 0011-112-1-2   | TO A COLUMNIA                | DATE       | 144        | ALTIT                                 | IDE            | <u>Y</u>    | 45. INCLIN                            | ATION  |               |
| 42. POINTING ACCU | URACY 43. POINTING           | KAIE       |            |                                       | IRCUL          | 1           |                                       |  | TROGRADE      |
| 46. SPECIAL RE    | OUIREMENTS                   |            |            | <u> </u>                              | TICOL          | 717         | JUN-JI                                | NOII ILL   | INOGRADE      |
|                   |                              |            |            | <u> </u>                              |                |             | <u> </u>                              |  |               |
| 47. COMPONEN      | TS                           |            |            |                                       |                |             | anguara.                              | ¥.   |               |
| *                 |                              |            |            |                                       |                |             |                                       |  |               |
| 48. WEIGHT        | 49. VOLUME                   | 5          | 0. AVERAG  |                                       | 51. STAND      | BY POW      | ER 52. PE                             | AK POWER   | 53. MTBF      |
| 30 LB             |                              |            | 19 WA      |                                       |                |             |                                       |  |               |
| 54. INTERFERENCE  | 55. MAGNETIC<br>INTERFERENCE | 56. NUCLE. | AR<br>ENCE | 57. THE                               | RMAL<br>ERENCE | 58. S       | HIELDING                              |  | ·             |
|                   |                              |            |            |                                       |                |             |                                       |  | ODGE DIVATION |
| 59. CALIBRATION   |                              | - 17t 7    | 60. DATA   | · · · · · · · · · · · · · · · · · · · |                |             |                                       |  | OBSERVATION   |
|                   | DY-SPACE VI                  | l th       | DELA       | YED                                   | TELEME         | TKY         | CO                                    | NTINUO   | JS            |
| JE. PELEWEIR      | · ULGOINEMENIS               |            |            |                                       |                |             |                                       |  |               |
|                   |                              |            |            |                                       |                |             |                                       |  |               |
|                   |                              |            |            |                                       |                |             |                                       |  |               |
| 63. ADVANTAG      | GES AND LIMITATIO            | NS         |            |                                       |                |             |                                       |  |               |
|                   |                              |            |            |                                       |                |             |                                       |  |               |
|                   | •                            |            |            |                                       |                |             |                                       |  |               |
| 64. REFERENC      | ES ·                         |            |            | in or a                               |                |             | u. umad                               | The second secon |               |
| FALBEL, G         | G.: DESIGN A                 | ND PE      | RFORM      | ANCE                                  | CHARA          | CTE         | RTSTTC                                | S OF TH  | IE.           |
| VERTICÁL          | TEMPERATUR                   | E PRO      | FILE       | RADI                                  | OMETER         | (V          | TPR) F                                | OR ATMO  | )S-           |
| PHERIC I          | EMPERATURE                   | SOUND      | INGS,      | PRES                                  | ENTED          | 8TH         | REMOT                                 | E SENS   | ING           |
| SYMPOSIU          | ľΜ                           |            | •          |                                       |                |             |                                       |  |               |
|                   |                              |            |            |                                       |                |             |                                       |  |               |
| 65. HISTORICA     | L REMARKS                    |            |            |                                       |                |             |                                       |  |               |
|                   |                              |            |            |                                       |                | <del></del> | · · · · · · · · · · · · · · · · · · · |  |               |
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|                   |                              |            |            |                                       |                |             |                                       |  |               |

| 1. TITLE             |                   |        |                         |       |      |                   |               | 2. /               | ACRONYM      | 3. EXP NO       |  |  |  |
|----------------------|-------------------|--------|-------------------------|-------|------|-------------------|---------------|--------------------|--------------|-----------------|--|--|--|
| VERY HIGH            | H RESOLUTION      | RAD    | IOMETER                 |       |      |                   |               | V                  | HR R         | NA              |  |  |  |
| (TITLE CONT.         | )                 |        |                         |       |      |                   |               | 4. R               | ESUME DATE   | 5.<br>VERSION   |  |  |  |
|                      |                   |        |                         |       |      |                   |               | 0.0                | 9/01/        | 72 0003         |  |  |  |
| 6. PRINCIPAL IN      | IVESTIGATOR       | 7. OR  | ORGANIZATION 8          |       |      |                   |               |                    | 8. TELEPHONE |                 |  |  |  |
| SHENK, W             | . E.              | GOD    | DARD SPAC               | CE FI | LT C | ENTER             | -30           | 1-982              | 2-504        | 2               |  |  |  |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION              |       |      |                   | 11. TELEPHONE |                    |              |                 |  |  |  |
| GOLDBERG             | , I. L.           | GOD    | DARD SPA                | CE F  | LTC  |                   |               | 1-982-5042         |              |                 |  |  |  |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INC           | EX NU | MBER | 15. START<br>DATE | 16. C         | OMPLETION<br>DATE  | 17. STA      | rus             |  |  |  |
|                      |                   |        |                         |       |      | 10/6              | 9             |                    |              |                 |  |  |  |
| 18. MONITOR          |                   | 19. AG | . AGENCY 20. PGM OFFICE |       |      |                   | 21. TELEPHONE |                    |              |                 |  |  |  |
| BURKE, J             | .R.               | NAS    | A HDQTRS                |       | OA   | 'ECS              | 20            | 2-75               | 5-232        | 2               |  |  |  |
| 22. VENDOR           | ***               |        | 23. LOCATION            | 1     |      |                   |               | 24. FLIGHT<br>DATE | 25. L        | EAD TIME        |  |  |  |
| ITT INDU             | STRIAL LABS       |        | FORT WAY                | YNE,  | INDI | ANA               |               |                    | 27           | MONTH           |  |  |  |
| 26. INSTRUMEN        | T TYPE            |        |                         |       |      |                   |               |                    |              | 27.<br>SECURITY |  |  |  |
| RADIOMET             | ER, SCANNING      | IR     | AND VISI                | BLE   |      |                   |               |                    |              | UNC             |  |  |  |
| 28. APPLICATIO       | N                 |        |                         |       | . ]  | 29. SPACE         | CRAF          | T                  |              |                 |  |  |  |
| ERSP, ME             | T, DCEAN          |        |                         |       |      | ATS-F             |               |                    |              |                 |  |  |  |
| 30. PURPOSE          |                   |        |                         |       |      |                   |               |                    |              |                 |  |  |  |

PRIMARY-TO OBSERVE CLOUD COVER AND CLOUD MOTION OVER A LARGE PORTION OF THE EARTH BOTH DAY AND NIGHT AND MEASURE CLOUD TOP OR EARTH'S SURFACE TEMPERATURE\*\*\*SECONDARY-ESTIMATE HEIGHTS OF CLOUD TOP SURFACES THROUGH TEMPERATURE MEASUREMENTS.

### 31. PRINCIPLES OF OPERATION

INSTRUMENT OPERATES OVER TWO CHANNELS: 0.55 TO 0.75 MICRON AND 10.5 TO 12.5 MICRONS. INCOMING RADIATION IS REFLECTED FROM THE SCAN MIRROR AND FOCUSED BY AN 8-IN DIAMETER F/3 CASSEGRAIN TELE-SCOPE AT THE CHOPPER. THE CHOPPER ALTERNATELY DIRECTS INCOMING RADIATION AND BLACK BODY REFERENCE RADIATION TO THE DETECTOR. AFTER CHOPPING, CHANNEL SEPERATION IS ATTAINED VIA A REFLECTING CHOPPER. A TWO-AXES SCAN MIRROR PRODUCES A TV-TYPE PICTURE VIA A FAST SCANNING MOTION AND A LINE-BY-LINE TILTING, STEP MOTION. THE LINE SCAN OCCURS BY TURNING THE SCANNING MIRROR SO AS TO SCAN THE FIELD AT A CONSTANT ANGULAR VELOCITY. THE VISIBLE DET-ECTOR, A SILICON PHOTOVOLTAIC DEVICE, OPERATES INTO A LOW IMPED-ANCE. THE VISIBLE CHANNEL HAS THE RESOLUTION OF THE IR CHANNEL. COVERAGE OF THE 20 X 20 DEGREE FIELD OF VIEW TAKES APPROXIMATELY 24 MINUTES. THE IR CHANNEL PRODUCES FULL EARTH PICTURES DAY AND NIGHT, AND HAS THE ADDED CAPABILITY OF TEMPERATURE MEASUREMENT FROM WHICH CLOUD HEIGHT MAY BE INFERRED USING STANDARD ATMOS-PHERIC CURVES. THE VISIBLE CHANNEL ALSO PROVIDES HIGH-RESOLUTION EARTH ALBEDO MEASUREMENTS.

### 32. PHENOMENA OBSERVED

RADIATION FROM EARTH'S SURFACE AND CLOUD COVER

### 33. MEASUREMENT RANGE

O DEG K TO 340 DEG K IN IR CHANNEL.

### 34. PRECISION AND ACCURACY

1.5 DEGREES K AT 200 DEGREES K, 1200 LINES PER PICTURE FRAME

| 35. SPECTRAL RANGE                      | <del></del>  | M. concer . Constall |  | 36. SPECTRA  | AL RESOLU | ITION                                   | 1000  | CONSTANT   |
|---|--|----------------------|--|--|-----------|---|---|--|
| 0.55 TO                                 | 12.5   | MI                   | CRONS  | SEE I  | TEM 31    |   | C   | .3MILSEC   |
| 38. FIELD OF VIEW                       |  | w                    | UND SWA  | hite   |           |   |   |  |
| 20 BY                                   | 0.023DEG   | 8 NM                 | AT SI  | JBSATEL  | LITE P    | OINT                                    | FROM  | SYNCH ALT  |
| 40. ANGULAR RESOLUTION 4                | 1. SPATIAL RES   | OLUTION              |  |  |           |   |   | . ]  |
| 0.023 DEG 8                             | NM AT S  | UBSAT                | ELLIT  | POINT  | FROM      | SYNC                                    | H ALTI  | TUDE   |
| 42. POINTING ACCURACY 43.               | POINTING RAT   | E                    | 44. ALT  | /  |           | NCLINA                                  |   |  |
|   |  |                      | SYNCI  | 1 CIRCU  | LAR EQ    | <b>UATOF</b>                            | RIAL P  | DSIGRADE   |
| 46. SPECIAL REQUIREME                   | an array of the second of the  |                      |  |  |           |   | After a second of the second                  | COLUMN CONTRACTOR CONT |
| DETECTOR COOL                           | .ED TO 90  | DEG                  | Κ.   |  |           |   | Marin - 14 - 2 mary - 10 - 10 - 11            |  |
| 47. COMPONENTS                          |  |                      |  |  |           |   |   | Commission of the Commission o |
| RADIOMETER, CA                          |  |                      |  |  |           |   |   |  |
| 48. WEIGHT 49. VOLU                     | and the second second second   |                      | man manada   | R 51. STAND  | BY POWER  |   |   |  |
| L                                       | .43 CU F   |                      | O WAT  |  | 1 1       |   | WATTS   | 3 YEAR   |
| 54. INTERFERENCE 55. INTERFE            |  | NUCLEAR<br>ERFERENCE | and the second s | REPRIVAL<br>REFERENCE  | 58. SHIEL |   | M TNC   |  |
| NONE NONE                               | LINU   | N E                  |  | SITIVE   | FAULAY    |   |   | BSERVATION .   |
| BLACKBODY REFE                          | DENCE  |                      | ATA REC  | 7 /  | TOV       |   |   | INUTES   |
| 62. TELEMETRY REQUIR                    |  | тса                  | - 1 TIAC   | TELEME   | 1 N f     | TACK,                                   | <u> </u>                                      | LINUIES  |
| 450 HZ INFORMA                          | and the state of t | OWINT                | H  | in a market in the control of the co |           | / ··· · · · · · · · · · · · · · · · · · | <u>, , , , , , , , , , , , , , , , , , , </u> |  |
| TOO HE INIONIA                          | CITON DAN  | DMIDI                | •  |  |           |   |   |  |
|   |  |                      | -  |  |           |   |   |  |
| 63. ADVANTAGES AND L                    | IMITATIONS   |                      |  |  |           |   |   |  |
| ADVANTAGE-TAKE                          | The same of the sa | ARTH F               | CTUE   | ES OVE   | 2 A 24    | HOUR                                    | PERT  | י מר   |
| CAN MEASURE S                           |  |                      |  |  |           |   |   | J. J.  |
| 64. REFERENCES                          | OF FOL T   | L,11, L,17,          | 11011  | IN CES   | ,         |   | - M J •                                       |  |
| 1) GOLDBERG, I                          | - I Δ '  | VFRY I               | IIGH R   | ESOLUT   | ION RA    | DIOME                                   | TRIC  | EXPERI-  |
| MENT FOR ATS-F                          |  |                      |  |  |           |   |   |  |
| 1                                       | A CO O Y   |                      |  |  |           |   |   |  |
|   |  |                      |  |  |           |   |   |  |
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|   |  |                      |  |  |           | •                                       |   |  |
| 65. HISTORICAL REMARI                   | KS   |                      |  | · · · · · · · · · · · · · · · · · · ·  |           |   |   |  |
|   |  | A-2400 A-4000 A-4    | The state of the s |  |           |   |   |  |
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| 1. TITLE             |                   |        |                                     |     |           |               |                   | ACRON                     | /M 3   | 3. E> | (P NO           |
|----------------------|-------------------|--------|-------------------------------------|-----|-----------|---------------|-------------------|---------------------------|--------|-------|-----------------|
| VERY HIG             | H RESOLUTION      | I RAI  | IOMETER                             |     |           |               | VF                | IRR                       |        |       |                 |
| (TITLE CONT.         |                   |        |                                     |     | .,,,      |               |                   | ESUME D                   |        |       | ERSION          |
|                      |                   |        |                                     |     |           |               | 99/               | 017                       | /2     | 10    | 1000            |
| 6. PRINCIPAL IN      | VESTIGATOR        | 7. OR  | GANIZATION                          |     |           |               |                   | PHONE                     |        |       |                 |
| J.O'BRIE             | EN                | GSI    | PC .                                |     |           | 98            | 32-50             | )42_                      |        |       |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION                          |     |           | 11. T         | ELEPHO            | )NE                       |        |       |                 |
|                      |                   |        |                                     |     |           |               |                   |                           |        |       |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | ER 14. FLASH INDEX NUMBER 15. START |     |           |               |                   | 16. COMPLETION 17. STATUS |        |       |                 |
| CPIF                 | NHS 5 10306       | ó      |                                     |     |           |               |                   | OPERATIONAL               |        |       | NAL             |
| 18. MONITOR          |                   | 19. AG | 19. AGENCY 20. PGM OFFICE           |     |           | 21. TELEPHONE |                   |                           |        |       |                 |
| GARBACZ,             | М.                | NASA   | A HDQTRS                            | OA/ | ERO       | 202           | 2-755-2322        |                           |        |       |                 |
| 22. VENDOR           |                   |        | 23. LOCATION                        |     |           |               | 24. FLIGH<br>DATE |                           | 5. LE/ | AD 1  | IME             |
| RCA AED              |                   |        | HIGHTSTOWN,                         | N.J | •         |               | 10/7              | 72                        |        |       |                 |
| 26. INSTRUMEN        | T TYPE            |        |                                     |     |           |               |                   |                           |        |       | 27.<br>SECURITY |
| RADIOMET             | [ER               |        |                                     |     |           |               |                   |                           |        |       |                 |
| 28. APPLICATIO       | N                 |        |                                     | :   | 29. SPACE | CRAF          | T                 |                           |        |       |                 |
| MET                  |                   |        |                                     |     | NOAA-2    | 2             |                   |                           |        |       |                 |
| 20 01100005          |                   |        |                                     |     |           |               |                   |                           |        |       |                 |

30. PURPOSE

PRIMARY-TO MEASURE EMITTED RADIATION FROM THE EARTH DURING THE DAY AND NIGHT TO MEASURE REFLECTED RADIATION FROM THE EARTH DURING DAYTIME. THE SYSTEM PERMITS DETERMINATION OF THE SURFACE TEMPERATURE OF THE GROUND, SEA, OR CLOUD TOPS THAT ARE VIEWED BY THE RADIOMETER.

### 31. PRINCIPLES OF OPERATION

THIS SCANNING RADIOMETER SYSTEM CONSISTS OF 2 REDUNDANT RADIO-METERS WITH SUPPORTING COMPONENTS. EACH HAS 2 DATA CHANNELS: AN IR(10.5-12.5 MICRONS) AND VISIBLE(0.6-0.7 MICRONS) BOTH WITH AN INSTANTANEOUS FOV OF .6 MILLIRADIANS. THE RADIOMETER SCANS THE EARTH'S SURFACE FROM HORIZON TO HORIZON. PERPENDICULAR TO THE ORBITAL PLANE BY MEANS OF A CONTINUOUSLY ROTATING MIRROR (400RPM WHICH IS INCLINED 45° TO ITS AXIS OF ROTATION. THE IR CHANNEL IS CALIBRATED AT THE COLD EXTREME BY MEASURING THE RESPONSE TO OUTER SPACE AND ON THE WARM SIDE BY MEASURING THE IR RADIATION FROM INSIDE THE RADIOMETER HOUSING THE VISIBLE CHANNEL IS CAL-IBRATED SEPARATELY. IN OPERATION, RADIATION REFLECTS FROM THE ROTATING MIRROR TO THE COLLECTING OPTICS, A 5 INCH IN DIAMETER DALL-KIRKHAM SYSTEM, AND IS THEN FOCUSED ON TO THE BEAM SPLITTER (DICHROIC MIRROR). THE LIGHT PASSES THROUGH AND IS MEASURED BY A SOLID STATE RADIANT ENERGY DETECTOR (PHOTO DIODE). THE IR IS RE-FLECTED FROM THE BEAM SPLITTER AND PASSED THROUGH 10.5-12.5 MIC-RON WAVELENGTH FILTER ONTO A RADIATIVELY COOLED HGCDTE DETECT-OR AT 105°K

### 32. PHENOMENA OBSERVED

ENERGY IN THE INFRARED AND VISIBLE REGION OF THE SPECTRUM

### 33. MEASUREMENT RANGE

VISIBLE BRIGHTNESS: 50-10,000 FT-LAMBERTS; IR TEMP: 180-330°K

### 34. PRECISION AND ACCURACY

1.0 K DEG AT 300 DEGK: 3K DEG AT 185 DEG K

| 36   |
|--|
| . 6 MILLIRADIANS   150 DEGREES LIMB TO LIMB (SAME AS SR)  40. ANGULAR RESOLUTION   41. SPATIAL RESOLUTION   . 6 MR   . 6 MR  42. POINTING ACCURACY   43. POINTING RATE   44. ALTITUDE   45. INCLINATION   . 790 NM   102°  46. SPECIAL REQUIREMENTS  47. COMPONENTS   2 RADIOMETERS  48. WEIGHT   49. VOLUME   50. AVERAGE POWER   51. STANDBY POWER   52. PEAK POWER   53. MTBF |
| 40. ANGULAR RESOLUTION  . 6 MR  . 6 MR  42. POINTING ACCURACY 43. POINTING RATE  |
| . 6 MR 42. POINTING ACCURACY 43. POINTING RATE 44. ALTITUDE 45. INCLINATION 46. SPECIAL REQUIREMENTS  47. COMPONENTS 2 RADIOMETERS  48. WEIGHT 49. VOLUME 50. AVERAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF  |
| 42. POINTING ACCURACY  |
| 46. SPECIAL REQUIREMENTS  47. COMPONENTS  2 RADIOMETERS  48. WEIGHT 49. VOLUME 50. AVERAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF   |
| 47. COMPONENTS 2 RADIOMETERS 48. WEIGHT 49. VOLUME 50. AVERAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF   |
| 2 RADIOMETERS  48. WEIGHT 49. VOLUME 50. AVERAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF   |
| 2 RADIOMETERS  48. WEIGHT 49. VOLUME 50. AVERAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF   |
| 48. WEIGHT 49. VOLUME 50. AVERAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF  |
|  |
| 21 LB. 7W EACH 1 YEAR  |
| 54 INTERFERENCE 55 MAGNETIC 56 NUCLEAR 57 THERMAL 58 SHIELDING   |
|  |
| 59. CALIBRATION 60. DATA RECOVERY 61. FREQUENCY OF OBSERVATION   |
| 62. TELEMETRY REQUIREMENTS   |
| VIDEO BANDWIDTH 35 KHZ   |
|  |
|  |
| 63. ADVANTAGES AND LIMITATIONS   |
| 1ST OPERATIONAL IR DETECTOR COOLED TO 105°K  |
| 64. REFERENCES   |
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| 65. HISTORICAL REMARKS   |
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### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771

| 1. TITLE                  |                   |        |                    |        |                   |                  |                     | RONYM    | 3. EXP NO                             |  |  |
|---------------------------|-------------------|--------|--------------------|--------|-------------------|------------------|---------------------|----------|---------------------------------------|--|--|
| VISIBLE/                  | INFRARED SPIN     | 1-SC/  | AN RADIOMETER      | ₹      |                   |                  | V13                 | SSR      |                                       |  |  |
| (TITLE CONT.              | .)                |        |                    |        | •                 |                  | 4. RES              | UME DATE | 5.<br>VERSION                         |  |  |
|                           |                   |        |                    |        |                   |                  | 09/                 | 0177     | 2 0002                                |  |  |
| 6. PRINCIPAL II           | NVESTIGATOR       | 7. OR  | GANIZATION         |        |                   | 8. TI            | ELEPHON             | E        | · · · · · · · · · · · · · · · · · · · |  |  |
| FORDYCE,                  | D. V.             | GODE   | ARD SPACE FL       | .T C   | ENTER             | 301              | -982-               | 982-5042 |                                       |  |  |
| 9. CO-INVESTIGATOR 10. OR |                   |        | GANIZATION         |        |                   |                  | ELEPHON             |          |                                       |  |  |
| WEINREB,                  | M. B.             | GOD    | DARD SPACE FL      | T C    | ENTER             | 301              | -982-               | -5042    |                                       |  |  |
| 12. CONTRACT<br>TYPE      | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | MBER   | 15. START<br>DATE | 16. <sup>C</sup> | OMPLETION 1         | 7. STATE | <b>US</b>                             |  |  |
|                           |                   |        |                    |        |                   |                  |                     |          |                                       |  |  |
| 18. MONITOR               |                   | 19. AG | ENCY               | 20. PG | M OFFICE          | 21. T            | ELEPHO              | NE'      |                                       |  |  |
| GARBACZ,                  | M.L.              | NASA   | HDQTRS             | OA/    | ERO               | 202              | ? <del>-</del> 755- | -2322    |                                       |  |  |
| 22. VENDOR                | ·                 |        | 23. LOCATION       | -      |                   |                  | 24. FLIGHT<br>DATE  | 25. LE   | AD TIME                               |  |  |
| SANTA BAR                 | RBARA RES.CEN     | ITER   | GOLETA, CALI       | F.     |                   |                  | 12/72               | ?        |                                       |  |  |
| 26. INSTRUMEN             | T TYPE            |        |                    |        |                   |                  |                     |          | 27.<br>SECURITY                       |  |  |
| RADIUMETE                 | ER                |        |                    |        | •                 |                  |                     |          | UNC                                   |  |  |
| 28. APPLICATIO            | N                 |        |                    |        | 29. SPACE         | CRAF             | T                   |          |                                       |  |  |
| MET                       |                   |        |                    |        | SMS-A             | 1                |                     |          |                                       |  |  |
| 30. PURPOSE               |                   |        |                    |        | ·                 |                  |                     |          |                                       |  |  |

PRIMARY-TO PROVIDE HIGH RESOLUTION SPIN SCAN PICTURES OF THE EARTH IN TWO SPECTRAL REGIONS (0.55-0.70 MICRONS AND 10.5-12.6 MICRONS).

### 31. PRINCIPLES OF OPERATION

THE SCANNER DESIGN USES A PLANE SCAN MIRROR AND PRIMARY OPTICS WHICH ARE COMMON TO THE VISIBLE AND THERMAL CHANNELS. THE SCAN MIRROR IS SET AT AN ANGLE TO THE RADIOMETER TELESCOPE (PRIMARY OPICS) AXIS WHICH IS ALIGNED PARALLEL TO THE SPIN AXIS OF THE SPACECRAFT. THE SPINNING MOTION OF THE SPACECRAFT. THEREFORE. PROVIDES AN EAST-WEST LINE SCAN MOTION WHEN THE SPIN AXIS OF THE SPACECRAFT IS ORIENTED PARALLEL WITH THE EARTH'S AXIS. RADIATION COLLECTED BY THE PRIMARY OPTICS IS IMAGED IN A PLANE BETWEEN THE PRIMARY AND SECONDARY MIRRORS. AT THIS POINT, THE VISIBLE AND THERMAL CHANNELS ARE OPTICALLY SEPERATED. FIBER OPTICS LIGHT-GUIDES ARE THE DEFINING FIELD STOP APERTURE FOR THE 8 VISIBLE CHANNELS. RADIATION INTERCEPTED BY EACH OF THE FIBER OPTIC LIGHT-GUIDES IS COLLIMATED BY A SPHERICAL LENS AND THEN FILTER-FOLLOWING FILTERING, THE COLLIMATED RADIATION IN EACH VI-SIBLE CHANNEL IS DIRECTED INTO A PHOTOMULTIPLIER TUBE HAVING AN S-20 RESPONSE. RADIATION FOR THE THERMAL CHANNEL IS RE-IMAGED BY MEANS OF A RELAY LENS ONTO AN INTRINSIC LONG WAVELENGTH DE-A 10.5 TO 12.6 MICRON BANDPASS FILTER IS LOCATED IN THE CONVERGING BEAM OF THE RELAY LENS SYSTEM AND ESTABLISHES THE SPECTRAL BAND LIMITS FOR THE THERMAL CHANNEL.

### 32. PHENOMENA OBSERVED

REFLECTED AND THERMAL RADIATION FROM EARTH'S SURFACE

### 33. MEASUREMENT RANGE

VISIBLE AND INFRARED SPECTRAL REGIONS

### 34. PRECISION AND ACCURACY

SIGNAL DYNAMIC RANGE: 44 DB-VISIBLE; 27-DB IR

| 35. SPECTRAL RANGE                         |  | 36. SPECTRA                                  | L RESOLUTION   | 37. TIME CONSTANT  |
|--|--|--|--|--|
| 0.55 TO 12.6                               | MICRONS  | SEE ITE                                      | the second secon | 40 MIN   |
| 38. FIELD OF VIEW                          | 39. GROUND SWA   | • · · · · · · · · · · · · · · · · · · ·      |  |  |
|  |  |  |  | · · · · · · · · · · · · · · · · · · ·  |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES     | DLUTION  | ÷ .  |  |  |
|  | SIBLE BAND   | S: 5 NM                                      | THERMAL B  | AND  |
| 42. POINTING ACCURACY 43. POINTING RAT     |  |  | 45. INCLINA  | ( · · / · · · · · · · · · · · · · · · ·  |
|  | SYNC   | H CIRCUL                                     | AR EQUATO  | RIAL POSIGRADE   |
| 46. SPECIAL REQUIREMENTS                   |  | . 6  |  | = .  |
| CRYOGENIC COLLING                          | - Marie Company of th |  |  |  |
| 47. COMPONENTS                             | www.   | - 12 - 15 - 16 - 16 - 16 - 16 - 16 - 16 - 16 |  | A STATE OF THE STA |
| PRIMARY OPICS, FIBER &                     | RELAY OPT  | ICS, FIL                                     | TERS, DET  | ECTORS   |
| 48. WEIGHT 49. VOLUME                      | 50. AVERAGE POW  | ER 51. STANDB                                | Y POWER 52. PEA  | K POWER 53. MTBF   |
| 133 LB 13.7 CU FT                          |  |  |  |  |
| S4. INTERFERENCE S6. INTERFERENCE S6. INTE | UCLEAR<br>RFERENCE 57. INT   | HERMAL<br>ERFERENCE                          | 58. SHIELDING  |  |
|  | SEN  | SITIVE                                       |  |  |
| 59. CALIBRATION                            | 60. DATA REC   |  |  | QUENCY OF OBSERVATION  |
| BLACKBODY . SUN & SPACE                    | DELAYED  | TELEMETR                                     | Y CONT   | INUOUSLY   |
| 62. TELEMETRY REQUIREMENTS                 |  |  |  |  |
| INFORMATION BANDWIDTH:                     | 225 KHZ V  | ISIBLE C                                     | HANNELS;   | 30 KHZ THERMAL   |
| 63. ADVANTAGES AND LIMITATIONS             |  | 20.  |  |  |
| UNIQUE RADIATION COOLE                     | Control and the control of the contr | and the Colombia and the Colombia            | OULTHE DE  | ID DECTECTORS  |
| FOR LONG DURATION SPACE                    |  | -  | DOCING OF  | IN DECIECIONS  |
| 64. REFERENCES                             | L MIJJIUMJ   | egit inge te og green and                    |  | · · · · · · · · · · · · · · · · · · ·  |
| 1)STEPHEN, A.A., ET.AL                     | DATA FI  | OW IN TH                                     | E SYNCHED  | NOUS METEORO-  |
| LOGICAL SATELLITE SYST                     |  |  |  |  |
| SIBLE INFRARED SPIN-SC                     |  |  |  |  |
| METEOROLOGICAL SPACECR                     |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| 65. HISTORICAL REMARKS                     | 19   |  |  |  |
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**SPECTROMETERS** 

|                      |                   |        | GREENBELT,     | VID. Z | .0771   |                   |        |                    |             |                 |
|----------------------|-------------------|--------|----------------|--------|---------|-------------------|--------|--------------------|-------------|-----------------|
| 1. TITLE             |                   |        |                |        |         |                   | VIII   |                    | CRONYM      | 3. EXP NO       |
| BACKSCAT             | TERED ULTRAVI     | OLE    | <b>RADIATI</b> | ON E   | XPE     | RIMEN             | T      | BU                 | JV -        |                 |
| (TITLE CONT.         |                   |        |                |        |         |                   |        | 4. RI              | SUME DATE   | 5.<br>VERSION   |
|                      |                   |        |                |        |         |                   |        | 0.5                | 77017       | 72 0008         |
| 6. PRINCIPAL II      | IVESTIGATOR       |        | GANIZATION     |        |         |                   |        | LEPHO              |             |                 |
| HEATH, D             | ₹. D.F.           | GODE   | DARD SPAC      | E FL   | T CI    | ENTER             | 301    | L <b>-</b> 982     | -5042       | 2 ·             |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION     |        |         |                   | 11. TI | ELEPHO             | NE          |                 |
| MATEER,              | C.L.              | NATI   | L CTR FOR      | AT     | 405     |                   |        |                    |             |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH IND  | EX NU  | MBER    | 15. START<br>DATE | 16. CC | MPLETION<br>DATE   | 17. STA1    |                 |
|                      |                   |        |                |        |         |                   |        |                    | OPERA       | ATIONAL         |
| 18. MONITOR          |                   | 19. AG | ENCY           |        | 20. PGM |                   |        | ELEPHO             |             |                 |
| SCHARDT,             | 8.8.              | NAS    | A HDQTRS       |        | OAZI    | ERN               | 202    | 2-75               | -2322       | 2               |
| 22. VENDOR           |                   |        | 23. LOCATION   |        |         |                   |        | 24. FLIGHT<br>DATE | 25. L       | EAD TIME        |
| BECKMAN              | INST. CORP.       |        | FULLERTO       | Ν, (   | CALI    | F.                |        | 04/7               | AN C'       | -               |
| 26. INSTRUMEN        |                   |        |                |        |         |                   |        |                    |             | 27.<br>SECURITY |
| SPECTROM             | ETER, EBERT-1     | TYPE   | GRATING        | ULT    | RAVI    | OLET              | PHO1   | TOME 1             | RIC         | UNC             |
| 28. APPLICATIO       | N                 |        |                |        | . 2     | 9. SPACE          | CRAF   | T                  |             |                 |
| MET                  |                   |        |                |        |         | NIMBU             | S-4    |                    |             |                 |
| 30. PURPOSE          |                   |        |                |        |         |                   |        |                    |             |                 |
| PRIMARY-             | TO MEASURE        | THE    | INTENSITY      | OF     | ULT     | RAVIO             | LET    | RAD                | INTIO       | N               |
|                      |                   | - 40   | T., A THACC    |        |         | C T E 14          | T &    | - T.               | C + + + + + | TOLLT           |

PRIMARY- TO MEASURE THE INTENSITY OF ULTRAVIOLET RADIATION BACKSCATTERED BY THE EARTH-ATMOSPHERE SYSTEM IN BOTH SUNLIGHT AND MOONLIGHT IN ORDER TO MONITOR THE SPATIAL DISTRIBUTION OF OZONE.

#### 31. PRINCIPLES OF OPERATION

THE MAIN INSTRUMENT IS A DOUBLE MONOCHROMATER COMPOSED OF TWO EBERT-TYPE MONOCHROMATERS IN TANDEM. EACH HAS A GRATING 64X64 MM WITH 3600 LINES/MM. LIGHT FROM A 0.05 STERADIAN SOLID ANGLE (SUBTENDING A 120X120 NM AREA ON THE EARTH'S SURFACE FROM 600NM) ENTERS THE NADIR POINTING INSTRUMENT THRU A DEPOLARIZING FILTER. A MOTOR-DRIVEN CAM STEP-ROTATES THE GRATINGS SO THAT THE INTEN-SITY OF 12 OZONE ABSORPTION BANDS ARE MONITORED AT 2555, 2735, 2830, 2876, 2922, 2975, 3019, 3058, 3125, 3175, 3312 AND 3398 A WITH A CENTER WAVELENGTH ACCURACY OF 0.2 A AND A BANDPASS OF 10A THE DETECTOR IS A PHOTOMULTIPLIER TUBE. SET BY THE SLIT SYSTEM. FOR BACKGROUND READINGS, A FILTER PHOTOMETER MEASURES THE RE-FLECTED UV IN A WAVELENGTH REGION (NEAR 4200 A) FREE OF OZONE ABSORPTION. SIGNALS FROM BOTH UNITS ARE READ BY SEPARATE RANGE-SWITCHING ELECTROMETERS WITH 7 DECADE RANGES. UNDER AVERAGE SUN-LIGHT CONDITIONS THE SIGNAL IS CALCULATED TO BE 3 MILLIAMP AT 3400 A DOWN TO 0.2 MICROAMPS AT 2550 A. A MEASUREMENT SUB-CYCLE TAKES 32 SECS. THERE ARE 192 SUB-CYCLES OR FRAMES INCLUDING 26 CALIBRATION FRAMES. ONCE EACH ORBIT THE FOV IS SWITCHED TO MON-THE VERTICAL DISTRIBUTION OF ITOR THE SUN OR MOON DIRECTLY. DZONE IS OBTAINED BY MATHEMATICAL INVERSION TECHNIQUES.

#### 32. PHENOMENA OBSERVED

ULTRAVIOLET RADIATION FROM THE EARTH'S ATMOSPHERE

#### 33. MEASUREMENT RANGE

SIGNAL CURRENT FROM 0.2 TO 3000 MICROAMPS

#### 34. PRECISION AND ACCURACY

WAVELENGTH TO 0.5 A; INTENSITY TO 2 PERCENT

| 35. SPECTRAL R   |                              |                             | <u>-</u>  | 36. SPECTR         | AL RES  | SOLUTIO  |       |         | E CONSTANT   |
|--|------------------------------|-----------------------------|---|--------------------|---------|----------|-------|---------|--|
| 2500   | TO 3400                      | <u> </u>                    |   | 10 A               |         |          |       | 32 3    | SEC  |
| 38. FIELD OF VIE   |                              |                             | OUND SWA  |                    |         |          |       |         |  |
| 13.  | •                            |                             |   | AM CIRC            | LE F    | FROM     | 600   | NM      | ALTITUDE   |
| ·  | UTION 41. SPATIAL            |                             |   |                    |         |          |       |         | •  |
| 12.  | DEG 126 NM                   | FROM 6                      | 00 NM   | ALTITUD            | E       |          |       |         |  |
|  | ACY 43. POINTING             | RATE                        | 44. ALTI  |                    |         | 45. INCL |       |         |  |
|  | EG                           |                             | MED   | CIRCUL             | AR      | SUN-     | SYN   | СН      | RETRUGRADE   |
| 46. SPECIAL REC  | UIREMENTS                    |                             |   |                    |         |          | ·     |         |  |
| •  |                              |                             |   | ,                  |         |          |       |         |  |
| 47. COMPONENT  | T                            |                             | - Carlotte |                    |         |          |       |         | Management of the company of the com |
| SPECTROME  | TER, PHOTO                   | METER,                      | ELECTR  | INICS              |         |          |       |         |  |
|  | 9. VOLUME                    |                             | VERAGE POWE   |                    | DBY POW | ER 52.   | PEAK  | POWE    | R 53. MTBF   |
| 32 LB  | 0.78 C                       |                             | 7 WAT   |                    |         |          |       |         |  |
| 54. INTERFERENCE   | 55. MAGNETIC<br>INTERFERENCE | 56. NUCLEAR<br>INTERFERENCE | 57. TI  | IERMAL<br>RFERENCE | 58. SI  | HIELDIN  | IG    |         |  |
|  |                              |                             |   |                    | . [     |          |       |         |  |
| 59. CALIBRATIO   | Ŋ                            |                             | DATA REC  |                    |         | 61.      | FREQU | JENCY C | F OBSERVATION  |
| SEE ITEM   | 31                           | D                           | ELAYED  | TELEME             | TRY     |          |       |         |  |
| the state of the s | REQUIREMENTS                 |                             |   |                    |         |          |       |         |  |
| INFORMATI  | ON STORED;                   | 13 REA                      | DINGS   | ITH 7              | BIT     | ACCU     | RAC   | Y, E    | ACH 0.5  |
| SEC. HOUS  | EKEEPING A                   | LSO.                        | -   |                    |         |          |       |         |  |
|  |                              |                             |   |                    |         |          |       |         |  |
|  | S AND LIMITATIO              |                             |   |                    |         |          |       |         |  |
| MOVING PA  | RTS; COMPL                   | ETE CYC                     | LE OF   | 92 FRE             | QUEN    | ICY S    | AMP   | LES     | TAXES 6144   |
| SECONDS.   |                              |                             |   |                    |         |          |       |         | •  |
| 64. REFERENCES   | i i                          |                             |   |                    |         |          |       |         |  |
|  | BAKER, N.B                   |                             |   |                    |         |          |       |         |  |
| GENERAL E  | LECTRIC CO                   | RP., PH                     | ILADEL  | PHIA, P            | A. * 1  | **21D    | AVE   | , J.    | V. AND   |
| HEATH, D.  | F.: PROPOS                   | AL TO D                     | ETERMI  | IE THE             | SPAT    | TAL      | DIS   | TRIE    | SUTION OF  |
| ATMOSPHER  | IC OZONE F                   | ROM MEA                     | SUREME  | ITS OF             | ULTR    | RAVIO    | LET   | RAD     | NOITAIO  |
| BACKSCATT  | ERED BY TH                   | E EARTH                     | 'S ATM  | SPHERE             | (NC     | V. 1     | 965   | ).      |  |
|  |                              |                             |   |                    |         |          |       |         |  |
| 65. HISTORICAL   | REMARKS                      |                             |   |                    |         |          | ·     |         |  |
|  |                              |                             |   |                    |         |          |       |         |  |
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#### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771

2. ACRONYM 3. EXP NO 1. TITLE FWS FILTER-WEDGE SPECTROMETER 5. VERSION (TITLE CONT.) 4. RESUME DATE 09/01/72 0006 7. ORGANIZATION 8. TELEPHONE 6. PRINCIPAL INVESTIGATOR GODDARD SPACE FLT CENTER 301-982-5042 HOVIS, DR. W. A. 11. TELEPHONE 10. ORGANIZATION 9. CO-INVESTIGATOR

| 12. CONTRACT | 13. CONTRACT | NUMBER | 14. FLASH INDEX | NUMBER  | 15. START<br>DATE | 16. C | OMPLETION DATE     | 17. STATUS    |
|--------------|--------------|--------|-----------------|---------|-------------------|-------|--------------------|---------------|
|              |              |        |                 |         |                   |       |                    | OPERATIONAL   |
| 18. MONITOR  |              | 19. AG | ENCY            | 20. PGM | OFFICE            | 21. 7 | <b>TELEPHO</b>     | NE            |
| SCHARDT      | , B.B.       | NAS    | A HDQTRS        | OA/     | ERN               | 20    | 2-755              | -2322         |
| 22. VENDOR   |              |        | 23. LOCATION    |         |                   |       | 24. FLIGHT<br>DATE | 25. LEAD TIME |

ITT INDUSTRIAL LABS. FORT WAYNE, INDIANA 04/70 NA

26. INSTRUMENT TYPE

SPECTROMETER. CIRCULAR-WEDGE INTERFERENCE-FILTER INFRARED UNC

SPECTROMETER, CIRCULAR-WEDGE INTERFERENCE-FILTER INFRARED

29. SPACECRAFT

MET

NIMBUS-4

30. PURPOSE

PRIMARY- TO DETERMINE THE LATERAL DISTRIBUTION OF THE TOTAL WATER VAPOR CONTENT PER UNIT VERTICAL COLUMN.\*\*\*SECONDARY- TO DETERMINE THE VERTICAL DISTRIBUTION OF WATER VAPOR CONTENT IN ANY PARTICULAR UNIT VERTICAL COLUMN. AND THE LATERAL VARIATION OF THE VERTICAL DISTRIBUTION.

#### 31. PRINCIPLES OF OPERATION

THE INSTRUMENT IS AN IR RADIOMETER WHICH PASSES INCIDENT RADIA-TION THROUGH A CONTINUOUSLY ROTATING (ONCE EVERY 16 SEC) FILTER THE FILTER WHEEL IS A 2-SEGMENT 100-LAYER INTERFERENCE FILTER WITH THE LAYER THICKNESS LINEARLY INCREASING AS A FUNC-TION OF ANGULAR POSITION, CAUSING THE BAND PASS TO SHIFT TOWARD THE LONGER WAVELENGTH. ONE SECTOR TRANSMITS THE 3.2-6.4 MICRON BAND AND THE OTHER THE 1.2-2.4 MICRON BAND. AN IMMERSED LEAD SELENIDE DETECTOR IS USED. INCIDENT RADIATION IS SAMPLED 20 TIMES A SECOND. THE RESULT IS A SPECTRAL INTENSITY PLOT OF 158 POINTS FOR EACH PASSBAND PER REVOLUTION. A TELESCOPE ORIENTED NORMAL TO THE EARTH'S SURFACE COLLECTS ATMOSPHERIC RADIATION FROM A 3 DEG FOV DIRECTLY BELOW THE SATELLITE. AT A 600NM ALTI-TUDE IN A SUN-SYNCHRONOUS ORBIT, A POLE-TO-POLE STRIP OF ATMOS-PHER 31 NM WIDE IS VIEWED ON EACH SATELLITE PASS WITH A 1330 NM SEPARATION BETWEEN SUCCESSIVE STRIPS AT THE EQUATOR. NARROW SPECTRAL REGIONS IN THE CO2 AND H2O ABSORPTION BANDS AT 4.3 AND 6.3 MICRON AND IN A WINDOW REGION ARE OF INTEREST. CALIBRATION IS ACCOMPLISHED BY CHOPPING AGAINST A BLACKBODY OF KNOWN TEMPER-ATURE, 27+-0.5 DEG C. THE SPECTRA ARE ANALYZED BY THE METHOD OF INVERSION OF RADIATIVE TRANSFER EQUATIONS.

#### 32. PHENOMENA OBSERVED

INFRARED SPECTRAL RADIANCE OF EARTH'S ATMOSPHERE

#### 33. MEASUREMENT RANGE

REFLECTIVE AND THERMAL IR REGIONS

34. PRECISION AND ACCURACY

| 35. SPECTRAL RANGE  | 36. SPECTRAL RESOLUTION                                   | 37. TIME CONSTANT                 |
|---|---|-----------------------------------|
| 1.2 TO 6.4 38. FIELD OF VIEW  | MICRONS 2.3 PERCENT                                       | 16. SECONDS                       |
|   | 39. GROUND SWATH  30 BY 30 NM FROM 600 NM AL              | TITUDE                            |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES                                  | SOLUTION  | JUL                               |
| 3. DEG 30 NM FRO  | M 600 NM ALTITUDE   |                                   |
| 42. POINTING ACCURACY 43, POINTING RAT                                  |   | <del></del>                       |
| 46. SPECIAL REQUIREMENTS  | MED CIRCULAR ISUN-SY                                      | NCH RETROGRADE                    |
| REFERENCE BLACK BODY M  | AINTAINED AT 300 DEG K                                    |                                   |
| 47. COMPONENTS  |   |                                   |
| SPECTROMETER. TELESCOP  | 50. AVERAGE POWER 51. STANDBY POWER 52. PE                |                                   |
| 13 LB0.3 CU F   |   | 33. 11131                         |
|   | NUCLEAR 57. INTERFERENCE 58. SHIELDING                    |                                   |
| ES CALIBRATION  | SENSITIVE RADIATIVE                                       |                                   |
| SEE ITEM 31   |   | EQUENCY OF OBSERVATION            |
| 62. TELEMETRY REQUIREMENTS  | IDELAYED TELEMETRY ICON                                   | IT I NUOUS                        |
| 298 BITS PER SECOND   |   |                                   |
|   |   |                                   |
| 63. ADVANTAGES AND LIMITATIONS  |   |                                   |
| LOW COST. LOW POWER DRA   | AIN, SIMPLE INSTRUMENT; RES                               | ULTS LIMITED TO                   |
| LOWER ALTITUDES. HAS ME   | OVING PARTS   | OE13 CIMITED TO                   |
| 64. REFERENCES  |   |                                   |
|   | UBSYSTEM DIRECTORY (PRELIM)                               |                                   |
| IFI FCTRIC CO DHILADELI   | DHTA. DA . DEC 1047 ***21                                 | MINITHEO DA                       |
| ELECTRIC CO., PHILADELE INTERIM REPORT ON SATE                          | PHIA, PA., DEC. 1967.***2)<br>LLITE METEOROLOGICAL INSTRU | MINZNER, R.A.,                    |
| ELECTRIC CO., PHILADELE INTERIM REPORT ON SATEL REPORT NO. PM-6713, JUN | LLITE METEOROLOGICAL INSTRU                               | MINZNER, R.A.,<br>MENTS. NASA/ERC |
| INTERIM REPORT ON SATEL   | LLITE METEOROLOGICAL INSTRU                               | MINZNER, R.A.,<br>MENTS. NASA/ERC |
| INTERIM REPORT ON SATEL   | LLITE METEOROLOGICAL INSTRU                               | MINZNER, R.A.,<br>MENTS. NASA/ERC |
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| INTERIM REPORT ON SATEUREPORT NO. PM-6713, JUN                          | LLITE METEOROLOGICAL INSTRU                               | MINZNER, R.A., MENTS. NASA/ERC    |
| INTERIM REPORT ON SATEUREPORT NO. PM-6713, JUN                          | LLITE METEOROLOGICAL INSTRU                               | MINZNER, R.A., MENTS. NASA/ERC    |
| INTERIM REPORT ON SATEUREPORT NO. PM-6713, JUN                          | LLITE METEOROLOGICAL INSTRU                               | MINZNER, R.A., MENTS. NASA/ERC    |
| INTERIM REPORT ON SATEUREPORT NO. PM-6713, JUN                          | LLITE METEOROLOGICAL INSTRU                               | MINZNER, R.A., MENTS. NASA/ERC    |
| INTERIM REPORT ON SATEUREPORT NO. PM-6713, JUN                          | LLITE METEOROLOGICAL INSTRU                               | MINZNER, R.A., MENTS. NASA/ERC    |
| INTERIM REPORT ON SATEUREPORT NO. PM-6713, JUN                          | LLITE METEOROLOGICAL INSTRU                               | MINZNER, R.A., MENTS. NASA/ERC    |

### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER

GREENBELT, MD. 20771

| 1  |              |        |                     |          |         |               |                    |         |      |  |  |
|--|--------------|--------|---------------------|----------|---------|---------------|--------------------|---------|------|--|--|
| 1. TITLE                                       | >            |        |                     |          |         |               | 2. ACF             | RONYM   | 3. E | XP NO  |  |
| INFRARED                                       | INTERFFROME  | TER/   | SPECTROMETER        |          |         |               | IRI                | S       |      | <u>.                                    </u> |  |
| (TITLE CONT.                                   | )            |        |                     |          |         |               | 4. RESU            | ME DATE | 5    | VERSION                                      |  |
|  |              |        |                     |          |         |               | 09/                | 01/     | 72   | 0005   |  |
| 6. PRINCIPAL INVESTIGATOR 7. ORGANIZATION 8. T |              |        |                     |          |         | 8. TE         | LEPHONE            | LEPHONE |      |  |  |
| HANEL, R                                       | . A.         | GOD    | DARD SPACE FL       | .T (     | ENTER   | 30            | L-982-             | 5042    | 2    |  |  |
| 9. CO-INVESTIG                                 | ATOR         | 10. OR | GANIZATION          |          |         | 11. T         | ELEPHON            | E       |      |  |  |
| CHANEY, L. UNIVERSITY OF MICHIGAN              |              |        |                     |          |         | 313-764-7210  |                    |         |      |  |  |
| 12. CONTRACT<br>TYPE                           |              |        |                     |          | DATE 17 | STA1          | rus                |         |      |  |  |
|  |              |        |                     |          |         |               |                    | PEP     | ΔTΙ  | JAAL   |  |
| 18. MONITOR                                    |              | 19. AG | ENCY 20. PGM OFFICE |          |         | 21. TELEPHONE |                    |         |      |  |  |
| SCHARDT,                                       | B • B •      | NAS    | A HDQTRS            | OA       | /ERN    | 20.           | 2 <b>- 7</b> 5 5-  | 2322    | 2    |  |  |
| 22. VENDOR                                     |              |        | 23. LOCATION        |          | ,       |               | 24. FLIGHT<br>DATE | 25L     | EAD  | TIME   |  |
| TEXAS IN                                       | STRUMENTS    |        | DALLAS, TEXA        | S        |         |               | 04/69              | NΔ      |      |  |  |
| 26. INSTRUMEN                                  | T TYPE       |        |                     |          |         |               |                    |         |      | 27.<br>SECURITY                              |  |
| SPECTROM                                       | ETER, INFRAR | ED I   | NTERFEROMETER       | <b>\</b> |         |               |                    |         |      | UNC  |  |
| 28. APPLICATION 29. SPACECRAFT                 |              |        |                     |          |         |               |                    |         |      |  |  |
| MET NIMBUS 3                                   |              |        |                     |          |         |               |                    |         |      |  |  |
| 30. PURPOSE                                    |              |        |                     |          |         |               |                    |         |      |  |  |
| DO IMADY -                                     | TO DETERMIN  | CTU    | E VEDITCAL DE       | OF I     | LIE OE  | TEN           | ADEDAT             | LIDE    | T    | uc   |  |

PRIMARY- TO DETERMINE THE VERTICAL PROFILE OF TEMPERATURE, THE VERTICAL DISTRUBUTIONS OF OZONE AND WATER VAPOR, AND THE TEMPER-ATURE OF THE EARTH'S SURFACE OR CLOUD TOPS.\*\*\*SECONDARY-TO IDENTIFY SOME OF THE GASES PRESENT IN THE ATMOSPHERE.

#### 31. PRINCIPLES OF OPERATION

THIS IS A TWYMAN-GREEN MODIFICATION OF A MICHELSON INTERFEROMET-ER SPECTROMETER OPERATING IN THE 5.0 TO 20 MICRON WAVELENGTH RE-TION WITH A FOV OF 8 DEGREES. RADIATION FROM A CYLINDER OF ATMOSPHERE, WHOSE BASE ON THE EARTH'S SURFACE IS A CIRCLE 80 NM IN DIAMETER, IS REFLECTED INTO THE INSTRUMENT FROM A PLANE MIR-ROR WHICH ROTATES TO PROVIDE IMC. THE RADIATION IS SPLIT INTO TWO BEAMS, ONE OF WHICH IS REFLECTED FROM A MOVING MIRROR, RE-COMBINED AND FOCUSED ONTO A BOLOMETER DETECTOR. INTERFERENCE EFFECTS RESULT FROM THE PATH LENGTH DIFFERENCES IN THE 2 BEAMS AS THE MIRROR MOVES. IT TRAVELS ABOUT 2 MM IN 11 SEC TO GIVE AN INTERFEROGRAM WHICH IS RECORDED ON TAPE. OBSERVATIONS ARE BEGUN 16 SEC APART IN WHICH TIME THE S/C TRAVELS ABOUT 65 NM. THUS THERE IS NO OVERLAP IN SUCCESSIVE OBSERVATIONS. AFTER RECORDING 14 INTERFEROGRAMS, 2 CALIBRATION OBSERVATIONS ARE MADE, ONE FOR A REFERENCE BLACKBODY AT 300 K AND ONE FOR OUTER SPACE. A FOURI-ER TRANSFORMATION, PERFORMED BY DIGITAL COMPUTER, MUST BE MADE ON EACH TELEMETERED INTERFEROGRAM TO PRODUCE A SPECTRUM. THEN. TO RELATE THIS TO ATMOSPHERIC CONDITIONS. APPROPRIATE SPECTRAL ABSORPTION REGIONS MUST BE CHOSEN AND EMPLOYED IN AN INVERSION OF THE RADIATIVE TRANSFER EQUALTIONS.

#### 32. PHENOMENA OBSERVED

EMISSION FROM THE EARTH FROM 5-20 MICRONS.

#### 33. MEASUREMENT RANGE

NEAR ZERO TO 300 DEGREES KELVIN

#### 34. PRECISION AND ACCURACY

FOR TEMP, 2 DEG C; FOR WATER VAPOR AND SCALE HEIGHT, 10 PER CENT

| 35. SPECTRAL RANGE                     |  | <u> </u>   |  | RESOLUTION   | 37. TIME CONSTANT   |
|--|--|--|--|--|---|
| 5.0 TO                                 | me et allegate mane  | 11CRONS  | 0.1  | MICRON   | 1.0 MILSEC  |
| 38. FIELD OF VIEW                      |  | ROUND SWAT   | and the second control of the contro | EDOM (66   | NIM ALTERIOR  |
| 8 . 0<br>40. ANGULAR RESOLUTION 41. SI |  |  | LIKULE   |  | NM ALTITUDE   |
|  | NM FROM 60   | The state of the s | TTTHOC   | :  |   |
|  |  |  |  |  | - mer - giarnes mana majijimpo e na mana majijimpo e na promo e na majijimpo e na promo e na majijimpo e na pr  |
| 42. POINTING ACCURACY 43. POI          | NIING KAIE   | 44. ALTITI   | and the same of th | 45. INCLINA  | <u> مستحمل المنتشاف التي ومساورة ويتنسون والمستحمل والمستحمل المستحمل والمستح</u> |
| AC CRECIAL REQUIREMENT                 |  | MED  | CIRCULAR   | 3011-31  | NUT KEIKUUKAU   |
| IMAGE MOTION COM                       |  | DECUIDE  | N TO EL I  | MINATE C   | MEAD  |
| 47. COMPONENTS                         | TPENSALIUN   | REQUIRE  | ) IO CLI   | IMINAIE 3  | PEAN  |
| MICHELSON INTERI                       | CEDOMETED (  | DECTROM  | TED DOT  | TATTUC MI  | DDOD BOLOMETER  |
| 48. WEIGHT 49. VOLUME                  |  | V At   | to a large of the same of the  | POWER 52. PEA  | man or a companion of a larger of the control of th      |
| 28 LB                                  |  | 12 WATT  |  | was a second second second second second second second second  | WATTS   |
| 54. INTERFERENCE 56. MAGNETIC          | 56. NUCLEAR  |  |  | B. SHIELDING   | MAITS   |
| INTERFERENCE INTERFERENCE              | E "INTERFERENC   | THE RESIDENCE THE PARTY OF THE  | CA 2500  | C Theory Activity and a second control of the contr | HIELDING REQ'D  |
| 59. CALIBRATION                        |  | ). DATA RECO   | A CONTRACTOR OF THE PARTY OF TH |  | QUENCY OF OBSERVATION   |
| SEE ITEM 31                            |  | ELAYED   |  |  | RY 16 SECONDS   |
| 62. TELEMETRY REQUIREM                 |  | LLATED   | · CLCMEIP  | TEAE   | W. TO DECOUDS   |
| 3.75 KBITS FOR                         | The state of the s | A CECONI   | 75. 10 4   | ECARITE  | DED OPRIT   |
| 3.13 KDITS FUR                         | 11 001 07 1  | TO SECUNI  | 73, TO 1   | EGADI IS   | PER UNDIT   |
|  |  |  |  |  |   |
| 63. ADVANTAGES AND LIMI                | TATIONS  |  | 4  |  |   |
| OVERLY WIDE (250                       |  | TTUDINA  | CEDADA   | TION AT  | EOUATOR   |
| LIMITED TO ABOVE                       |  | JITUUI NA  | L SEPANA   | TION AT  | ENUATURY :  |
| 64. REFERENCES                         | = CL9093.  |  |  | Trans-tu-wraene-tu-tu-tu-tu-tu-tu-tu-tu-tu-tu-tu-tu-tu-  |   |
| 1) MINZNER, R.A.                       | EN. THITEE   | TH DEDOI   | OT ON CA   | TELLITE  | MCTEODOL OCICAL   |
| INSTRUMENTS, NAS                       |  |  |  |  |   |
| L. CHANEY: THE                         |  |  |  |  | •   |
| (IRIS): VOL,2-ME                       |  |  |  |  |   |
| 65-75.***3)HANE                        |  |  | •  |  |   |
| OF AN IRIS TO OF                       | •  |  |  |  |   |
| 65. HISTORICAL REMARKS                 | JIAIN PILI L   | ATA. US  | CNFIA  | (-020-00-  | 4104 OC 1 1400 •  |
|  |  | *  | <u>Vandaman Öli<sup>®</sup>damasının ananını</u>   | <u> </u>   | Harris on the state of the stat      |
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### INSTRUMENT RESUME NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

GODDARD SPACE FLIGHT CENTER
GREENBELT, MD. 20771

| 1. TITLE             |                  |        |               |        |       |                   |          |                  | CRONYM    | 3. EXP    | NO     |
|----------------------|------------------|--------|---------------|--------|-------|-------------------|----------|------------------|-----------|-----------|--------|
| INFRARED             | INTERFEROME      | TER/   | SPECTROME     | TER    |       |                   |          | IR               | 12.       |           |        |
| (TITLE CONT.         | )                |        |               |        |       |                   |          | 4. RES           | SUME DATE | 5.<br>VEF | RSION  |
|                      |                  |        |               |        |       | _                 |          | 09               | 7017      | 5 00      | 308    |
| 6. PRINCIPAL II      | NVESTIGATOR      | 7. OR  | GANIZATION    |        |       |                   | 8. TEL   |                  |           |           |        |
| HANEL, R. A. GO      |                  |        | DARD SPAC     | CE FL  | T CI  | ENTER             | 301-     | 982              | -5042     | 2         |        |
| 9. CO-INVESTIG       | ATOR             | 10. OR | GANIZATION    |        |       |                   | 11. TEL  |                  |           |           |        |
| CONRATH,             | DR. B.           | GOD    | DARD SPAC     | JE FL  | .T C  | ENTER             |          |                  | -5042     | ?         |        |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUM | BER    | 14. FLASH INC | DEX NU | MBER  | 15. START<br>DATE | 16. COMP |                  | 17. STAT  |           |        |
|                      |                  |        |               |        |       |                   |          |                  | OPERA     | TION      | NAL    |
| 18. MONITOR          |                  | 19. AG | ENCY          |        |       | OFFICE            | 21. TEL  |                  |           |           |        |
| SCHARDT,             | B.B.             | NAS    | A HDQTRS      |        | DAZ   | ERN               | 202-     | 755              | -2322     |           |        |
| 22. VENDOR           |                  |        | 23. LOCATIO   |        |       |                   | 24       | L FLIGHT<br>DATE | 25. L     | EAD TII   | ME     |
| TEXAS IN             | STRUMENTS        |        | DALLAS,       | TEXA   | 12    |                   | 0        | 4/7              | ONA       |           |        |
| 26. INSTRUMEN        |                  |        |               |        |       |                   |          |                  |           | 27<br>SE  | CURITY |
| SPECTROM             | ETER, MODIFI     | ED M   | ICHELSON      | INF    | RAREI | DINT              | ERFER    | OME              | TER       |           | JNC    |
| 28. APPLICATIO       | N                |        |               |        |       | 9. SPACE          |          |                  |           |           |        |
| MET                  | ,                |        |               |        |       | NIMBU             | S-4      |                  |           |           |        |
| 30. PURPOSE          |                  |        |               |        |       |                   |          |                  |           |           |        |
| PRIMARY-             |                  |        | E VERTICA     |        |       |                   |          |                  |           |           |        |
| OZONE DI             | STRIBUTION,      | VERT   | ICAL WAT      | ER V   | APOR  | DIST              | RIBUT    | ION              | AND       | ) TEM     | 4-     |

#### 31. PRINCIPLES OF OPERATION

THIS IS A TWYMAN-GREEN MODIFICATION OF A MICHELSON INTERFEROMET-ER SPECTROMETER OPERATING IN THE 6.5 TO 40 MICRON WAVELENGTH RE-GION. RADIATION FROM A CYLINDER OF ATMOSPHERE, WHOSE BASE ON THE SURFACE OF THE EARTH IS A CIRCLE OF 53 NM IN DIAMETER, IS RE-FLECTED INTO THE INSTRUMENT FROM A PLANE MIRROR WHICH ROTATES TO PROVIDE IMAGE MOTION COMPENSATION. THE RADIATION IS SPLIT INTO 2 BEAMS, ONE OF WHICH IS REFLECTED FROM A MOVING MIRROR, RECOMBIN-ED AND FOCUSED ONTO A BOLOMETER DETECTOR. INTERFERENCE EFFECTS RESULT FROM THE PATH LENGTH DIFFERENCES IN THE TWO BEAMS AS THE IT TRAVELS ABOUT 2 MM IN 13 SEC TO GIVE AN INTER-MIRROR MOVES. FEROGRAM WHICH IS RECORDED ON TAPE. OBSERVATIONS ARE BEGUN 16 SEC APART IN WHICH TIME THE S/C TRAVELS ABOUT 65 NM THUS THERE IS NO OVERLAP IN SUCCESSIVE OBSERVATIONS. AFTER RECORDING 14 INTERFEROGRAMS, TWO CALIBRATION OBSERVATIONS ARE MADE, ONE FOR A REFERENCE BLACKBODY AT 300 K AND ONE FOR OUTER SPACE. A FOURIER TRANSFORMATION, PERFORMED BY DIGITAL COMPUTER MUST BE MADE ON EACH TELEMETERED INTERFEROGRAM TO PRODUCE A SPECTRUM. RELATE THIS TO ATMOSPHERIC COMDITIONS APPROPRIATE SPECTRAL ABSORPTION REGIONS MUST BE CHOSEN AND EMPLOYED IN AN INVERSION OF THE RADIATIVE TRANSFER EQUATIONS.

#### 32. PHENOMENA OBSERVED

EMITTED IR ENERGY FROM EARTH AND ITS ATMOSPHERE

PERATURE OF EARTH'S SURFACE OR CLOUD TOPS.

#### 33. MEASUREMENT RANGE

THERMAL IR ENERGY

#### 34. PRECISION AND ACCURACY

TEMPERATURE TO 2 DEG K; TOTAL WATER VAPOR AND SCALE HEIGHT 5%.

|                                       | T   |                                       |
|---------------------------------------|---|---------------------------------------|
| 35. SPECTRAL RANGE                    | 36. SPECTRAL RESOLU   |                                       |
| 6.5 TO 40.0                           | MICRONS 0.32 PER  | CENT 16. SECUNDS                      |
| 38. FIELD OF VIEW                     | 39. GROUND SWATH  |                                       |
| 5. DEC                                | 53 NM DIAM CIRCLE FROM  | 600 NM ALTITUDE                       |
| 40. ANGULAR RESOLUTION 41. SPATIAL RE | SOLUTION  |                                       |
| 5. DEG 53 NM FRO                      | M 600 NM ALTITUDE   |                                       |
| 42. POINTING ACCURACY 43. POINTING RA | TE 44. ALTITUDE 45. I   | NCLINATION                            |
|                                       | MED CIRCULAR SU   | N-SYNCH RETRUGRADE                    |
| 46. SPECIAL REQUIREMENTS              |   |                                       |
| 70. 00 2017LT 1120011LT 101.0         |   |                                       |
| 47 COMPONIENTS                        | Additional to the state of the |                                       |
| 47. COMPONENTS INTERFEROMETER SPECTRO | Western Classification of S   |                                       |
|                                       |   | EA DEAK DOWER TO MEDE                 |
| 48. WEIGHT 49. VOLUME                 |   | 52. PEAK POWER 53. MTBF               |
| 38 LB 0.3 CU F                        |   | 24 WATTS                              |
| 54. INTERFERENCE 56. INTERFERENCE 56. | NUCLEAR ST. WHERE SERVICE 58. SHIEL   | .DING                                 |
|                                       | SENSITIVE   |                                       |
| 59. CALIBRATION                       | 60. DATA RECOVERY   | 61. FREQUENCY OF OBSERVATION          |
| BLK BODY AND COLD SPACE               | E DELAYED TELEMETRY   | CONTINUOUS                            |
| 62. TELEMETRY REQUIREMENTS            |   |                                       |
|                                       | FOR 13 OUT OF 16 SECON  | O.S.                                  |
| Stry K Bird Fen Geoon                 |   |                                       |
|                                       |   |                                       |
|                                       |   |                                       |
| 63. ADVANTAGES AND LIMITATIONS        |   |                                       |
|                                       | LID CLOUD COVER, LIMITE   |                                       |
| [PARTIAL CLOUD COVER, ]               | MC REQUIRED, MOVING PAR   | TS                                    |
| 64. REFERENCES                        |   |                                       |
| 1) MINZNER. R.A. ED.:                 | NTERIM REPORT ON SATELL   | ITE METEOROLOGICAL                    |
|                                       | PM-6713, JUNE 1967.***2   |                                       |
|                                       | SENERAL ELECTRIC CO., PH  |                                       |
|                                       | RG, I.L.: METEOROLOGICAL  |                                       |
|                                       |   |                                       |
| SAIELLITES. PRESENTED                 | AT 13TH ANNUAL SYMPOSIU   | M UP 3PIE; AUG. 00.                   |
|                                       |   |                                       |
| 65. HISTORICAL REMARKS                | · ·   |                                       |
| _                                     |   |                                       |
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### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER

GREENBELT, MD. 20771

| 1. TITLE             | •                 |               |  |       |           |                   | 2. 4          | ACRONYM                               | 3.           | EXP NO          |
|----------------------|-------------------|---------------|--|-------|-----------|-------------------|---------------|---------------------------------------|--------------|-----------------|
| INFRARED             | SPECTROMETER      | ?: <b>E</b> / | ARTH RESOURCE                                | ES E  | XP ER I   | 1EN               | T IF          | ₹S .                                  | S-           | -191            |
| (TITLE CONT.         | )                 |               |  |       |           |                   | 4. R          | ESUME DATE                            |              | 5.<br>VERSION   |
| PACK AGE             | (EREP)            |               |  |       | _         |                   | 09            | 7/01/                                 | 72           | 0004            |
| 6. PRINCIPAL IN      | VVESTIGATOR       | GANIZATION    |  |       | 8. T      | ELEPHO            | PHONE         |                                       |              |                 |
| BARNET, 1            | r. L.             | NED SPACECRAF | FT C   | ENTER | 71:       | 3-483             | 3-012         | 3                                     |              |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR        | GANIZATION                                   |       |           | 11. T             | ELEPHO        | NE                                    |              |                 |
|                      |                   |               |  |       |           |                   |               |                                       |              |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER            | 14. FLASH INDEX NUMBER 15. START DATE 16. CI |       |           | OMPLETION<br>DATE | 17. STATUS    |                                       |              |                 |
|                      |                   |               |  |       |           |                   |               | ENG.                                  | MC           | DEL             |
| 18. MONITOR          |                   | 19. AG        | SENCY 20. PGM OFFICE 21.                     |       |           | 21. 1             | <b>TELEPH</b> | ONE                                   |              |                 |
| FISCHETTI            | I, T.L.           | NAS           | A HDQTRS DA/ERS                              |       |           | 202-755-          |               | 5-232                                 | 2            |                 |
| 22. VENDOR           |                   |               | 23. LOCATION                                 |       |           | 24. FLIGHT 2      |               | <sup>7</sup> 25. l                    | 5. LEAD TIME |                 |
| BLOCK ENG            | GINEERING CO.     |               |  |       |           |                   | 197           | 73                                    |              |                 |
| 26. INSTRUMEN        | T TYPE            |               |  |       |           |                   |               |                                       |              | 27.<br>SECURITY |
| SPECTROME            | TER               |               |  |       |           |                   |               |                                       |              | UNC             |
| 28. APPLICATIO       | N                 |               |  |       | 29. SPACE | CRAF              | Т             |                                       |              |                 |
| ERSP                 |                   |               |  |       | SKYLAE    | 3-A               |               |                                       |              |                 |
| 30. PURPOSE          |                   |               |  |       |           |                   |               | · · · · · · · · · · · · · · · · · · · |              |                 |

PRIMARY-TO PERFORM CONTROLLED EXPERIMENTS TO DETERMINE SUITABIL-ITY OF NEAR AND THERMAL IR REGIONS FOR EARTH RESOURCES SENSING FROM ORBITAL ALTITUDES\*\*\*SECONDARY-TO QUANTITATIVELY EVALUATE EFFECTS OF ATMOSPHERIC ATTENUATION ON RADIATION FROM GROUND TARGETS.

#### 31. PRINCIPLES OF OPERATION

THE SPECTROMETER IS OF FILTERWHEEL DESIGN. UTILIZING TWO CONTIN-UOUSLY VARIABLE INTERFERENCE FILTERWHEELS COVERING THE RANGES .4 TO 2.4 MICRONS AND 6.2 TO 15.5 MICRONS. SPECTRAL RESOLUTION IS 1% TO 4% IN WAYELENGTH, WITH A SCAN RATE OF ONE SCAN PER SECOND THROUGH THIS REGION. THE OPTICAL SYSTEM UTILIZES A 10-INCH CAS-SEGRAIN PRIMARY, AND HAS A FOV OR SPATIAL RESOLUTION OF 1 MRAD. AT LEAST TWO DETECTORS ARE REQUIRED TO COVER THE SPECTRAL RE-GIONS. COOLING TO 77 DEG K REQUIRED BY THE HG-CD-TI THERMAL DE-TECTOR IS ACCOMPLISHED WITH A SOLID CRYOGEN. SI, GA-AS, PB-SE, IN-AS, AND PB-S ARE CANDIDATE SHORT WAVELENGTH DETECTORS. TEM SENSITIVITIES ARE +-O.1 DEG K NET IN THERMAL REGION (300 DEG K TARGET AND BACKGROUND, NO ATMOSPHERE) AND +-0.1% NET IN THE REFLECTIVE REGION (SOLAR RADIANCE AT EARTH, NO ATMOSPHERE). INFLIGHT CALIBRATION IS ACHIEVED WITH TWO BLACKBODY SOURCES KNOWN TO +.1 DEG K AND ONE SHORT WAVELENGTH SOURCE OF RADIANCE KNOWN TO +.1%. BY COMPARING DATA COLLECTED FROM THE SPECTRO-METER WITH DATA TAKEN SIMULTANEOUSLY ON THE GROUND AND FROM AIR-CRAFT, INVESTIGATORS WILL BE ABLE TO ASSES THEIR REQUIREMENTS REGUARDING IR SENSOR CAPABILITY, SENSITIVITY, SPECTRAL RESOLU-TION. AND EVALUATE THE UTILITY OF REMOTE SENSING FROM SPACE.

32. PHENOMENA OBSERVED

REFLECTED AND THERMAL RADIATION FROM EARTH

33. MEASUREMENT RANGE

VISIBLE, NEAR IR, AND THERMAL WAVELENGHTS

34. PRECISION AND ACCURACY

8% ABSOLUTE IN 0.4-2.4 MICRON REGION, 72% BEYOND.

| 35. SPECTRAL RANGE           |                     | 36. SPECTRAL RES   |                              |
|------------------------------|---------------------|--|------------------------------|
| 0.4 TO                       | . 15.5 MI           | CRONS SEE ITEM   | 31 1.0 SEC                   |
| 38. FIELD OF VIEW            |                     | OUND SWATH   |                              |
| 0.05                         |                     | * IN REFERENCE   | BELOW                        |
| 40. ANGULAR RESOLUTION 41.   |                     |  |                              |
| 0.057 DEG                    |                     | HISTORICAL REMAR   |                              |
| 42. POINTING ACCURACY 43. PC | DINTING RATE        | 1  | 5. INCLINATION               |
| **                           |                     | 235 NM   | 50 DEG                       |
| 46. SPECIAL REQUIREMENT      |                     | TON MICT HAVE TO   | ANEWYTYANCE OF A O           |
|                              | UMING RADIA         | IUN MUST HAVE IK   | ANSMITTANCE OF 0.9           |
| 47. COMPONENTS               | CC FILTERU          | ICEL DETECTORS E   | TI M AND MACHETYC TARE       |
|                              |                     |  | ILM AND MAGNETIC TAPE        |
| 300 LB 11.                   |                     | ERAGE POWER 51. STANDBY POWE   | R 52. FEAR FOWER 53. MIDF    |
| S4. INTERFERENCE 55. MAGNETI |                     |  | IIELDING                     |
| INTERFERENCE INTERFERE       | NCE ON INTERFERENCE | SENSITIVE  | ITELDING                     |
| 59. CALIBRATION              | len i               | DATA RECOVERY  | 61. FREQUENCY OF OBSERVATION |
| SEE ITEM 31                  |                     | OM FILM AND TAPE   |                              |
| 62. TELEMETRY REQUIREM       |                     | CA A SET MITO TALL   | 1 The tap F X to lot tap his |
|                              |                     |  |                              |
|                              |                     |  |                              |
|                              |                     |  |                              |
| 63. ADVANTAGES AND LIM       | ITATIONS            | · · · · · · · · · · · · · · · · · · ·  |                              |
|                              |                     | CLOUD-FREE REGI  | DVS.                         |
|                              |                     | . Jawas . Mat. MEVI  | - · - •                      |
| 64. REFERENCES               |                     |  |                              |
| EXPERIMENT IMPL              | EMENTATION P        | LAN FOR MANNED S   | PACEFLIGHT EXPERI-           |
| MENTS-TITLE: IN              |                     |  |                              |
|                              |                     | ISING SYSTEMS. MS  | C-P6-0406                    |
| * MANUAL TARGE               | T TRACKING H        | ITH VIEWFINDER/T   | RACKING SYSTEM. V/TS         |
| LOOK ANGLE 45                | DEG. AHEAD          | 10 DEG. BEHIND,  | AND 20 DEG.EITHER            |
| SIDE OF NADI                 | R. 235 NM OR        | BIT.   |                              |
| 65. HISTORICAL REMARKS       |                     | and the second s |                              |
| ** PRED. MANUA               | L ACQUISITIO        | N OF 0.25 NM WIT   | HIN A 1 NM CIRCLE            |
|                              |                     |  |                              |
| i                            |                     |  |                              |
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| 1. TITLE             |                   |                  |                     |             |                   |       | 2. A                | CRONYM       | 3. E | XP NO           |
|----------------------|-------------------|------------------|---------------------|-------------|-------------------|-------|---------------------|--------------|------|-----------------|
| METEROLOG            | CICAL INFRARE     | D SP             | ECTROMETER          |             |                   |       | MIF                 | ₹\$          |      |                 |
| (TITLE CONT.         |                   |                  | •                   |             |                   |       | 4. RES              | SUME DATE    | 5    | ERSION          |
| 8-CHANNE             | L                 |                  |                     |             |                   |       | 09,                 | /01/7        | 2    | 0005            |
| 6. PRINCIPAL IN      |                   | 7. OR            | GANIZATION          |             |                   | 8. TE | ELEPHON             | 1E           |      |                 |
| WARK, DR.            | NO                | JAA 301-735-2000 |                     |             |                   |       |                     |              |      |                 |
| 9. CO-INVESTIG       |                   | 10. OR           | GANIZATION          |             |                   | 11. T | ELEPHO              | NE           |      |                 |
| HILLEARY,            | D.T.              | NAT              | ENV SAT CTR,        | NO          |                   |       | -735                |              |      |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER               | 14. FLASH INDEX NUM | <b>IBER</b> | 15. START<br>DATE | 16. C | OMPLETION -         | 17. STAT     | US   |                 |
|                      |                   |                  |                     |             |                   |       | [{                  | <b>JPERA</b> | TIC  | DNAL            |
| 18. MONITOR          | <u></u>           | 19. AG           | ENCY                | 20. PG/     | M OFFICE          | 21. T | TELEPHO             | NE           |      |                 |
| SCHARDT,             | B • B •           | NASA             | A HDQTPS            | OA/         | ERN               | 202   | 2 <del>-</del> 755- | -2322        |      |                 |
| 22. VENDOR           |                   |                  | 23. LOCATION        |             |                   |       | 24. FLIGHT<br>DATE  | 25. L        | EAD  | TIME            |
| ESSA                 |                   |                  | SUITLAND, MA        | RYL         | AND               |       | 04/69               | 9 NA         |      |                 |
| 26. INSTRUMEN        |                   |                  |                     |             |                   |       |                     |              |      | 27.<br>SECURITY |
| SPECTROME            | TER, 8-CHANN      | IEL !            | IR FASTIE-EBE       | RT          | FIXED-            | -GRA  | ATING               |              |      | UNC             |
| 28. APPLICATIO       |                   |                  |                     |             | 29. SPACE         |       |                     |              |      |                 |
| MET                  |                   |                  |                     |             | NIMBUS            | 3     |                     |              |      |                 |
| 30 PURPOSE           |                   |                  |                     |             |                   |       |                     |              |      |                 |

PRIMARY- TO MEASURE THE TEMPERATURE PROFILE FROM THE EARTH'S SURFACE OR CLOUD TOPS TO 15 MILE ALTITUDE.\*\*\*SECONDARY- TO MEASURE SURFACE TEMPERATURE OR CLOUD TOP TEMPERATURE AND ITS HEIGHT.

#### 31. PRINCIPLES OF OPERATION

THE INSTRUMENT IS A FASTIE-EBERT GRATING INFRARED SPEC-TROMETER WITH A WEDGE-IMMERSED THERMISTOR BOLOMETER AS DETECTOR AT EACH OF 8 EXIT SLITS. RADIATION IS MONITORED IN 7 INTERVALS (5-8 INV. CM. HALF POWER BANDWIDTHS) IN THE CO2 BAND FROM 13 TO 15 MICRONS AND IN 1 INTERVAL IN THE ATMOSPHERIC WINDOW AT 11.1 MICRONS. A TWO POSITION PLANE MIRROR REFLECTS EITHER A BLACK BODY CALIBRATION SOURCE OR EARTH RADIATION TO A CHOPPER WHICH ALTERNATELY VIEWS THIS RADIATION OR COLD SPACE. FROM THERE THE RADIATION PASSES THRU AN ORDER LIMITING INTERFERENCE FILTER, STRIKES A 25 IN. FOCAL LENGTH SPHERICAL MIRROR, A 5 IN. -1250 LINES/IN. DIFFRACTION GRATING, THE SPHERICAL MIRROR AGAIN, AND FINALLY THE EXIT SLITS. EARTH RADIATION IS GATHERED CONTINUOUSLY FROM A VIEWING ANGLE OF 0.04 STERADIAN (12X12 DEG) CENTERED ON THIS GIVES DATA ALONG A NORTH-SOUTH STRIP WHOSE PRO-THE NADIR. JECTION ON THE GROUND IS 120 NM WIDE. ADJACENT STRIPS ARE SEP-ARATED BY ABOUT 1600 NM AT THE EQUATOR. THE 11.1 MICRON DATA GIVES SURFACE OR CLOUD TOP TEMPERATURES. THE 15 MICRON DATA IS USED A GENERATE VERTICAL, TEMPERATURE-PRESSURE PROFILES BY A MATHEMATICAL INVERSION TECHNIQUE. DATA IS ACCUMULATED IN 6 SEC INTERVALS TO GIVE PROFILES EACH 50 MILES ALONG THE STRIP.

#### 32. PHENOMENA OBSERVED

IR RADIATION EMITTED FROM THE EARTH'S ATMOSPHERE, SURFACE, CLOUDS 33. MEASUREMENT RANGE

#### 34. PRECISION AND ACCURACY

TEMP TO 1 DEG K; PRESSURE TO 10 MB

| 35. SPECTRAL RANGE   | 36. SPECTRAL RESOLUTIO                  | N 37. TIME CONSTANT      |
|--|---|--------------------------|
| 11.1 TO 15.0   | MICRONS 0.6 PERCE                       | VT                       |
| 38. FIELD OF VIEW  | 39. GROUND SWATH                        |                          |
|  | 120 NM BY 120 NM FROM 60                | NM ALTITUDE              |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES   |   |                          |
|  | DM 600 NM ALTITUDE                      | ANATION .                |
| 42. POINTING ACCURACY 43. POINTING RAT   |   | INATION DETROCRADE       |
| 46. SPECIAL REQUIREMENTS   | MED CIRCULAR SUN-                       | STICH RETRUGRADE         |
| 40. SPECIAL REQUIREMENTS   |   |                          |
| 47. COMPONENTS   |   |                          |
|  | ROMETER, CALIBRATION SOUR               | CE. ELECTRONICS          |
| 48. WEIGHT 49. VOLUME  | 50. AVERAGE POWER 51. STANDBY POWER 52. | PEAK POWER   53. MTBF    |
| 91 LB 4. CU F  |   |                          |
| 54. INTERFERENCE 56. MAGNETIC 56. INTERFERENCE 56. INTERFERENCE  | THERMAL 57. THERMAL SR. SHIELDIN        | G                        |
| SENSITIVE  | SENSITIVE                               |                          |
| 59. CALIBRATION  | JOS. DATA HEOGYCH                       | FREQUENCY OF OBSERVATION |
|  | CE DELAYED TELEMETRY.   C               | ONTINUOUS                |
| 62. TELEMETRY REQUIREMENTS   | 10.017.100/00101                        | VOLCO HITTHIA SAC        |
| 1  | H 10 BIT ACCURACY, ALL SA               |                          |
| MILLISECUNDS AND TELEM   | ETERED TWICE EVERY 16 SEC               | 2 מאר                    |
| 63. ADVANTAGES AND LIMITATIONS   |   |                          |
| O. ADVANIAGED AND EMMITATION   |   |                          |
|  |   | 1                        |
| 64. REFERENCES   |   |                          |
| 1) GOLDBERG, I.L.: MET   | EDROLOGICAL IR INSTRUMENT               | S FOR SATELLETES.        |
| The state of the s | AL TECH SYMP OF SPIE, AUG               | •                        |
| NIMBUS B PRESS KIT, NA   | SA RELEASE NO. 68-84K, MA               | Y 1968.***3)             |
| MINZNER, R.A. ED: INTE   | RIM REPORT ON SATELLITE M               | ETEOROLOGICAL            |
| INSTRUMENTS, NASA ERC  | PM-6713, JUNE 1967.                     | •                        |
|  |   |                          |
| 65. HISTORICAL REMARKS   |   |                          |
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#### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION **GODDARD SPACE FLIGHT CENTER** GREENBELT, MD. 20771

| 1. TITLE             | •                                     |        |                    |         |                   |        | 2. ACR             | ONYM        | 3. E | XP NO           |
|----------------------|---------------------------------------|--------|--------------------|---------|-------------------|--------|--------------------|-------------|------|-----------------|
| MAPPING N            | ICROWAVE SPE                          | CTRO   | DMETER             |         |                   |        | MMS                |             |      |                 |
| (TITLE CONT.         | .)                                    |        |                    |         |                   |        | 4. RESU            | NE DATE     | П    | 5.<br>VERSION   |
|                      |                                       |        |                    |         |                   |        | 0970               | 3177        |      | 3002            |
| 6. PRINCIPAL II      | NVESTIGATOR                           | 7. OR  | GANIZATION         | LEPHONE | PHONE             |        |                    |             |      |                 |
| STAELIN,             | D. H.                                 | MASS   | INST. OF           | TECH    | 1.                | 617    | -864-              | 5900        |      |                 |
| 9. CO-INVESTIG       | ATOR                                  | 10. OR | GANIZATION         |         |                   | 11. TE | LEPHONE            |             |      |                 |
| BARATH, F            | T.                                    | JET    | PROPULSION (       | LABS    | •                 | 213    | -354-4             | +321        |      |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB                     | ER     | 14. FLASH INDEX NU | MBER    | 15. START<br>DATE | 16. CO | MPLETION 17        | . STAT      | US   |                 |
| -                    |                                       |        |                    |         |                   | ,      | PI                 | <b>ROPO</b> | SA   | L               |
| 18. MONITOR          |                                       | 19. AG | ENCY               | 20. PG  | M OFFICE          | 21. T  | ELEPHON            | E           |      |                 |
| SCHARDT,             | B • B •                               | NASA   | HDQTRS             | OA/     | 'ERN              | 202    | -755-              | 2322        | -    |                 |
| 22. VENDOR           |                                       |        | 23. LOCATION       |         |                   |        | 24. FLIGHT<br>DATE | 25. LI      | EAD  | TIME            |
|                      | · · · · · · · · · · · · · · · · · · · |        |                    |         | -                 |        | 1974               |             |      |                 |
| 26. INSTRUMEN        | T TYPE                                |        |                    |         |                   |        |                    | - <b>A</b>  |      | 27.<br>SECURITY |
| SPECTROME            | TER, MICROWA                          | VE F   | RADIOMETER         |         |                   |        |                    |             |      | UNC             |
| 28. APPLICATIO       | N                                     |        |                    |         | 29. SPACE         | CRAFT  | 7                  |             |      |                 |
| MET                  |                                       |        |                    |         | NIMBUS            | 5-F    |                    |             |      |                 |
| 30. PURPOSE          |                                       |        |                    |         |                   |        |                    |             | -    |                 |
| PRIMARY-1            | O MAP TROPOS                          | PHER   | RIC TEMPERATU      | JRE     | PROFIL            | ES.    | WATE               | R VA        | PO   | R               |

ABUNDANCE. AND CLOUD WATER CONTENT.

#### 31. PRINCIPLES OF OPERATION

THE INSTRUMENT IS A 5-CHANNEL MICROWAVE RADIOMETER. EACH OF THE DICKE SUPERHETERODYNE TYPE UTILIZING ALL SOLID STATE COMPONENTS. THE INSTRUMENT WILL MAP THERMAL RADIATION AT 5 WAVELENGTHS NEAR THE 5-MM OXYGEN AND 13.5-MM WATER VAPOR RESONANCES: 22.23, 31.4, 53.3, 53.85, AND 54.9 GHZ. BANDWIDTH ON ALL CHANNELS IS 200MHZ. EACH WAVELENGTH IS AFFECTED TO A DIFFERENT DEGREE BY THE TERRES-TRIAL SURFACE, CLOUDS, PRECIPITATION, WATER VAPOR AND TEMPERA-TURE PROFILE. BY APPROXIMATELY INTERPRETING A SET OF SIMULTANE-OUS EQUATIONS, MOST OF THE PARAMETERS CAN BE ESTIMATED SEPARATE-TRUE TEMPERATURE PROFILES WILL BE INFERRED TO WITHIN 2 OR 3 DEG K AND WILL BE UNAFFECTED BY CIRRUS CLOUDS OR CLOUDS WITH LESS THAN 0.05-G/CU CM LIQUID WATER CONTENT. THE TWO CHANNELS NEAR 1-CM WAVELENGTH PERMIT WATER VAPOR CLOUD WATER CONTENT OVER CALM OCEAN TO BE ESTIMATED SEPARATELY. THE DYNAMIC RANGE FOR ALL CHANNELS WILL BE FROM 0 TO 400 DEG K WITH +-0.1% LINEARITY. SENSITIVITY OF THE OXYGEN RADIOMETERS WILL BE BETTER THAN 1 DEG K RMS AND THAT OF THE H20 RADIOMETERS BETTER THAN 0.5 DEG K RMS, ALL WITH A 2\*\*2 SECOND INTEGRATION TIME. THE ABSOLUTE AC-CURACY OF ALL RADIOMETERS WILL BE BETTER THAN 2 DEG K RMS, LONG TERM.

#### 32. PHENOMENA OBSERVED

THERMAL RADIATION FROM EARTH, ATMUSPHERE, AND CLOUDS

#### 33. MEASUREMENT RANGE

OXYGEN AND WATER VAPOR RESONANCE LINES

#### 34. PRECISION AND ACCURACY

SEE ITEM 31

| 35. SPECTRAL RANGE                |           |             |                                       | 36. SPECT           |      |          |         |             | CONSTANT   |
|-----------------------------------|-----------|-------------|---------------------------------------|---------------------|------|----------|---------|-------------|--|
| 5.47 TO 1                         | 3•5       | MM          |                                       | SEE                 | TTE  | M 31     |         | SEE         | ITEM 31  |
| 38. FIELD OF VIEW                 |           |             | JND SWA                               |                     |      |          |         |             |  |
| 10 BY 10                          |           |             |                                       | 1200                | NM   | FROM     | 600     | NM AL       | TITUDE   |
| 40. ANGULAR RESOLUTION 41. SPATIA |           | JTION       | · · · · · · · · · · · · · · · · · · · |                     |      |          |         |             |  |
| 10 DEG 100 N                      |           |             |                                       |                     |      |          |         |             |  |
| 42. POINTING ACCURACY 43. POINTIN | G RATE    |             | 44. ALT                               |                     | A 13 |          |         | TION (      | TRUGRADE   |
| AC CRECIAL PROLUBRICATION         |           | i           | MED                                   | CIRCU               | _ AK | 30       | 14-21   | NON RE      | TAUGRAUE   |
| 46. SPECIAL REQUIREMENTS          |           |             |                                       | <del></del>         |      |          |         |             |  |
| 47. COMPONENTS                    |           |             |                                       |                     |      |          |         |             |  |
| RADIOMETERS, SCANN                | ING HO    | RNS         | • CAL                                 | IBRAT               | ION  | PLAT     | ES      |             |  |
| 48. WEIGHT 49. VOLUME             |           |             |                                       |                     |      |          |         | K POWER     | 53. MTBF   |
|                                   | CU FT     |             | TAW C                                 |                     |      |          |         |             | the same of the same of  |
| RF 54. INTERFERENCE 55. MAGNETIC  | 56. NUCLE | AR<br>RENCE | 57. INT                               | HERMAL<br>ERFERENCE | 5    | B. SHIEL | DING    |             |  |
|                                   |           |             |                                       |                     |      |          |         |             |  |
| 59. CALIBRATION                   |           |             | ATA REC                               |                     |      |          | <u></u> | <del></del> | OBSERVATION  |
| ON BOARD                          |           | TEL         | LEMET                                 | RY                  |      |          | CON     | TINUOL      | IS   |
| 62. TELEMETRY REQUIREMENTS        |           |             |                                       |                     |      |          |         |             |  |
| -                                 |           |             |                                       |                     |      |          |         |             |  |
|                                   |           |             |                                       |                     |      |          |         |             |  |
| 63. ADVANTAGES AND LIMITATION     | ONS       |             |                                       | •                   |      |          |         |             | The state of the s |
| CO. AS VALUE AND LIMITATION       |           |             |                                       |                     |      | ,        |         |             |  |
| ·                                 |           |             |                                       |                     |      |          |         |             |  |
| 64. REFERENCES                    |           |             |                                       |                     |      |          |         |             |  |
| PRELIMINARY DATA S                | HEET F    | OR I        | VIMBU                                 | S-F, 1              | VOV. | , 19     | 70.     |             | <del></del>  |
| l <i>.</i>                        |           |             |                                       |                     |      |          |         |             |  |
|                                   |           |             |                                       |                     |      |          |         |             |  |
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|                                   |           |             |                                       |                     |      |          |         |             |  |
|                                   |           |             | -                                     |                     |      |          |         |             |  |
| 65. HISTORICAL REMARKS            |           |             |                                       |                     |      |          |         |             |  |
|                                   |           |             |                                       |                     |      |          |         |             |  |
| ļ                                 |           |             |                                       |                     |      |          |         |             |  |
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|   |  | (                                     | GREENBELT, MD. 2       | 20771        |                   |             |                      |       |               |
|---|--|---------------------------------------|------------------------|--------------|-------------------|-------------|----------------------|-------|---------------|
| 1. TITLE  |  |                                       | •                      |              |                   |             | 2. ACRON             | /м 3. | EXP NO        |
| MONITOR (   | OF ULTRAVIOL                                 | ET S                                  | DLAR ENERGY            |              |                   |             | MUSE                 |       |               |
| (TITLE CONT.  | )  |                                       | •                      |              |                   |             | 4 RESUME D           |       | 5.<br>VERSION |
|   |  |                                       |                        |              |                   |             | 09/01                | 772   | 0007          |
| 6. PRINCIPAL IN   |  | L                                     | GANIZATION             |              |                   |             | EPHONE               |       |               |
| HEATH, DI   | R. D. F.                                     | GODI                                  | DARD SPACE FI          | LTC          | ENTER             | 301-        | -982 <del>-</del> 50 | 42    |               |
| 9. CO-INVESTIG  | ATOR   | 10. OR                                | GANIZATION             |              |                   | 11. TEL     | EPHONE               |       |               |
|   |  |                                       |                        |              | I IS START        | 5000        | N STION LAW CO       |       |               |
| 12. CONTRACT<br>TYPE  | 13. CONTRACT NUMB                            | ER                                    | 14. FLASH INDEX NU     | MBER         | 15. START<br>DATE | 16. COM     |                      | ATUS  |               |
|   | -  | 40.40                                 |                        |              |                   |             |                      | KAI   | IONAL         |
| 18. MONITOR   | D O  | 19. AG                                |                        |              | OFFICE            |             | LEPHONE              | 33    |               |
| SCHARDT,  | 8.8.   | NAS                                   | A HDQTRS  23. LOCATION | UA/          | ERN               |             | -755-23              |       | D TIME        |
| 22. VENDOR  | ORPORATION                                   |                                       | WALTHAM, MA            | <u> </u>     |                   |             | DATE                 | IA    | D TIME        |
| 26. INSTRUMEN   |  |                                       | MALIFIAM MA            | 33.          |                   |             | 34770] N             | IA .  | 27.           |
|   | ETER, 6-CHANI                                | MEI I                                 | OPTICAL-EILT           | FR D         | HOTOD             | IODE        |                      |       | UNC           |
| 28. APPLICATIO  |  | 1 L L                                 | DITTORE TIET           |              | 29. SPACE         |             |                      |       | 10,46         |
|   | M-PHYS                                       |                                       |                        |              | NIMBU             |             |                      |       | WIII .        |
| 30. PURPOSE   |  | · · · · · · · · · · · · · · · · · · · |                        |              | 1111100           | <del></del> | <del>.</del>         |       |               |
|   | TO DETECT VAR                                | RIAT                                  | TON OF RELAT           | IVF          | INTEN             | SITY        | OF SOL               | ΔR    | FLUX          |
|   | CTRAL BANDS                                  |                                       |                        |              |                   |             |                      |       |               |
|   | TMOSPHERE;**                                 |                                       |                        |              |                   |             |                      |       |               |
|   | . TO MEASURE                                 |                                       |                        |              |                   |             |                      |       |               |
| LITE ENTERS THE EARTH SHADOW NEAR THE POLES, TO MEASURE OZONE |  |                                       |                        |              |                   |             |                      |       |               |
|   | AND MOLECULAR OXYGEN HIGH IN THE ATMOSPHERE. |                                       |                        |              |                   |             |                      |       |               |
|   | OF OPERATION                                 |                                       |                        |              |                   |             |                      |       |               |
| THIS EXPERIMENT IS SIMILAR TO THE ONE FLOWN ON NIMBUS-2 BUT   |  |                                       |                        |              |                   |             |                      |       |               |
| WITH MING   | OR VARIATIONS                                | S. TI                                 | HE ULTRAVIOLI          | ET S         | ENSOR:            | S COM       | VSIST C              | FF    | IVE           |
| PHOTODIO  | DES WHOSE SHO                                | ORT 1                                 | WAVELENGTH RI          | ESPO         | NSE I             | S DE        | TERMINE              | D B   | Υ             |
| SUITABLE  | OPTICAL FILT                                 | TERS                                  | , WHILE THE I          | LONG         | WAVE              | LENG"       | TH CUTO              | FF    | 13            |
| DETERMIN  | ED BY VARYING                                | G DE                                  | GREES OF SOI           | _AR          | BLIND             | VESS!       | OF DI                | FFE   | RENT          |
| PHOTOCATI   | HODE MATERIA                                 | ALS.                                  | THE FIVE C             | HANN         | ELS I             | HAVE        | RESPO                | NSE   | s             |
| TO RADIA  | ATION IN TH                                  | E FO                                  | DLLOWING RAT           | <b>NGES</b>  | : 130             | 00 -        | 1600 A               | •     | 1750-         |
| 1850A, 2  | 750-3150A, 20                                | 350-2                                 | 2150A, AND 2           | 760-         | 2860A             | . A S       | SOLAR A              | SPE   | CT            |
| SENSOR G  | IVES THE ANGL                                | LE AT                                 | WHICH THE              | SUN!         | S RAY             | S STF       | RIKE TH              | E D   | IODES         |
| WITH 7-B  | IT ACCURACY.                                 | US                                    | ABLE DATA IS           | OBT          | AINED             | OVER        | R A 90               | DEG   | FOV-          |
| THE RADIA   | ATION INTENS                                 | ITY :                                 | IS READ AS TI          | HE C         | URREN'            | r FRO       | OM THE               | PHO   | TO-           |
|   | Y EITHER OF 2                                |                                       |                        |              |                   |             |                      |       |               |
| RANGES. 1   | THERE IS AN A                                | AUTO                                  | MATIC ZERO SI          | ETTI         | NG DE             | VICE        | FOR TH               | EE    | LEC-          |
| TROMETERS   | S. THEY ARE (                                | CALI                                  | BRATED USING           | 5 C          | ONSTAI            | NT CL       | <b>JRRENTS</b>       | SU    | P-            |
| PLIED BY  | A RADIOACTIV                                 | /E SC                                 | DURCE (AM 24)          | L).          | AN EX             | PERIN       | MENT CY              | CLE   |               |
|   | SEC INCLUDIA                                 |                                       |                        |              |                   |             |                      |       |               |
| AND SENSO   | OR DATA. EACH                                | 4 SEN                                 | ISOR IS MONI           | TORE         | D FOR             | 5 SE        | C PER                | CYC   | LE.           |
| THIS DATA   | A WILL BE COP                                | RRELA                                 | ATED WITH DA           | TA F         | ROM TI            | HE BL       | JV EXPE              | RIM   | ENT           |
| TO HELP (   | JNDERSTAND TI                                | HE SO                                 | DLAR INFLUENC          | CE O         | N THE             | STRA        | TOSPHE               | RE.   | THE           |
| ABSOLUTE  | ACCURACY OF                                  | THE                                   | MEASUREMENT!           | S WI         | LL BE             | 20 F        | PERCENT              | •     |               |
| 32. PHENOMENA   | A OBSERVED                                   |                                       |                        |              |                   |             |                      |       |               |
|   | ET SOLAR RAI                                 | TAIC                                  | ION FLUX               |              |                   |             |                      |       |               |
| 33. MEASUREM  |  |                                       |                        |              |                   |             |                      |       |               |
| SIGNAL CU   | JRRENT FROM (                                | 0.1                                   | NANDAMP TO 1           | <u> 00 N</u> | IMACMA            | PS          | . <u>.</u>           |       |               |
|   | AND ACCURACY                                 |                                       |                        | _            |                   |             |                      |       |               |
| <b>ARPORTOLE</b>  | ACCURACY OF                                  | FLU)                                  | MEASUREMEN'            | T WI         | THIN 2            | 20 PE       | ERCENT.              |       |               |

| 35. SPECTRAL RANGE                 |            | <del></del> - |          | 36.      | SPECTRA   | L RES   | OLUTION      |             | CONSTANT    |
|------------------------------------|------------|---------------|----------|----------|-----------|---------|--------------|-------------|-------------|
| 1300. TO 3150                      | •          | Δ             |          | L        | 100.      | Δ       |              | 48          | • SECONDS   |
| 38. FIELD OF VIEW                  |            |               | UND SWA  |          |           |         |              |             |             |
| 90.                                | DEG 8      | 50            | VM FR    | OM       | 600       | NM C    | RBIT         |             |             |
| 40. ANGULAR RESOLUTION 41. SPATIA  |            |               |          |          |           |         |              |             |             |
| C.7 DEG 7 NM F                     | ROM 6      | 000           | NM AL    | TI       | TUDE      |         |              |             |             |
| 42. POINTING ACCURACY 43. POINTING | RATE       |               | 44. ALT  |          |           |         | 45. INCLIN   |             |             |
|                                    |            |               | MED      |          | TRCUL     | AK      | SUN-S        | YNCH I      | RETROGRADE  |
| 46. SPECIAL REQUIREMENTS           | - 11 T T T |               | ura a    | -        |           | A 11    |              | <del></del> |             |
| TEMPERATURE MUST BE                | MAIN       | HALI          | NEO B    | <u> </u> | WEEN      | U AN    | いっつつ         | JEG C.      |             |
| 47. COMPONENTS                     | C 71       | <del></del>   | DONIE    | _        |           |         |              |             |             |
| PHOTODIODE DETECTOR                |            |               |          |          | 51 07115  | DV 0000 | - 52 05      | AK POWER    | 53. MTBF    |
| 48. WEIGHT 49. VOLUME              |            | 0. AVE        | RAGE POW | ER_      | 51. STAND | BY POW  | 52. FE       | AKTOWEN     | 33. WI BF   |
| S4 INTERFERENCE S5 MAGNETIC        | 56. NUCLE  | AR            | 57. INT  | HERM     | IAL       | EO CL   | HELDING      |             | <u> </u>    |
| SENSITIVE                          | INTERFER   | RENCE         | ST. INT  | ERFER    | RENCE     | 50. SF  | TELDING      | <del></del> |             |
| 59. CALIBRATION                    | <u> </u>   | 60 D          | ATA REC  | ·OV      | FRY       | L       | 61. FR       | EQUENCY OF  | OBSERVATION |
| CONSTANT CURRENTS                  |            |               |          |          | ELEME     | TRY     |              |             | RORBIT      |
| 62. TELEMETRY REQUIREMENTS         |            | 1 ~ - !       |          | <u> </u> |           |         |              |             |             |
| 30 BIT DIGITAL WORD                | ) REAL     | ONO           | CE EV    | ΕP       | Y SEC     | OND     | AT 4         | KBITS       | PER SEC.    |
|                                    |            |               |          | -        |           |         |              |             | -           |
|                                    |            |               |          |          |           |         |              |             |             |
| 63. ADVANTAGES AND LIMITATIO       | NS         |               |          |          |           |         |              |             |             |
|                                    |            |               |          |          |           |         |              |             |             |
| ļ                                  |            |               |          |          |           |         |              |             |             |
| 64. REFERENCES                     |            |               |          |          |           |         |              |             |             |
| 1) NORMYLE, W.J.: N                | IMBUS      | В             | TO TE    | ST       | NEW       | WEAT    | HER S        | ENSORS      | •           |
| TEMPERATURE MUST BE                | MAIN       | TAI           | NED B    | ET       | WEEN      | 5 AN    | D 40         | DEGREE      | sc.         |
| 2) PRESS KIT NIMBUS                | 8 . N      | IASA          | RELE     | AS       | E NO:     | 68-     | 48K,         | MAY 19      | 58.***3     |
| FRANKLIN, W.: SUBSY                | STEM       | DIR           | ECTOR    | Y        | REVIS     | ED,     | <b>GENER</b> | AL ELE      | CTRIC CO.,  |
| PHILADELPHIA, PA.                  |            |               |          |          | •         |         |              |             |             |
|                                    |            |               |          |          |           |         |              |             |             |
| 65. HISTORICAL REMARKS             |            |               |          |          |           |         |              |             |             |
|                                    |            |               |          |          | ·         |         | · .          |             |             |
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### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER

GREENBELT, MD. 20771

|                      |                   |               |  | 7        |              |               |                    |            |                 |
|----------------------|-------------------|---------------|--|----------|--------------|---------------|--------------------|------------|-----------------|
| 1. TITLE             |                   |               |  |          |              |               | 2. /               | CRONYM     | 3. EXP NO       |
| POSITIVE             | ION COMPOSIT      | FION          | SPECTROMETER   | <u> </u> |              |               | PΙ                 | CS         |                 |
| (TITLE CONT.         | )                 |               | ·  |          |              |               | 4, R               | ESUME DATE | 5.<br>VERSION   |
|                      |                   |               |  |          |              |               | 0.9                | 701/7      |                 |
| 6. PRINCIPAL IN      | IVESTIGATOR       | 7. OR         | RGANIZATION 8. TELEPHONE                                 |          |              |               |                    |            |                 |
| TAYLOR, H            | 1. Δ., JR.        | DARD SPACE FL | T C  | ENTER    | 301-982-5042 |               |                    |            |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR        | GANIZATION   |          |              | 11. TELEPHONE |                    |            |                 |
| BRINTON.             | H. C              | GODE          | DARD SPACE FL  | TC       |              |               |                    | -5042      | E               |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER            | ER 14. FLASH INDEX NUMBER 15. START DATE 16. COMPLE DATE |          |              | DATE          | PLETION 17. STATUS |            |                 |
|                      |                   |               |  |          |              |               |                    | PROPO      | DSAL            |
| 18. MONITOR          |                   | 19. AG        | ENCY   | 20. PGN  | OFFICE       | 21. T         | ELEPHO             | NE         |                 |
| SCHARDT,             | B.B.              | NAS           | A HDQTRS   | QA/      | ERN          | 202           | 2 <del>-</del> 755 | -2322      | ?               |
| 22. VENDOR           |                   |               | 23. LOCATION   |          |              |               | 24. FLIGHT<br>DATE | 25. L      | EAD TIME        |
|                      |                   |               |  |          |              |               | 197                | 4          |                 |
| 26. INSTRUMEN        | T TYPE            |               |  |          |              |               |                    |            | 27.<br>SECURITY |
| MASS SPEC            | CTROMETER         |               |  |          |              |               |                    |            | UNC             |
| 28. APPLICATIO       | N                 |               |  | 2        | 9. SPACE     | CRAF          | T                  |            |                 |
| IONOSPHER            | RE AND RADIO      | PHY:          | SICS   |          | NIMBUS       | S-F           |                    |            |                 |
| 30. PURPOSE          |                   |               |  |          |              |               |                    |            |                 |

PRIMARY-TO DETERMINE THE GLOBAL DISTRIBUTION OF UPPER ATMOSPHERE ICN COMPOSITION WITH EMPHASIS ON 'SOLAR-GEOMAGNETIC' SEASONAL VARIATIONS WHICH MAY REVEAL A LINK BETWEEN ENERGETIC PROCESSES ACTIVE IN BOTH UPPER AND LOWER ATMOSPHERE REGIONS.

#### 31. PRINCIPLES OF OPERATION

AMBIENT, THERMAL, POSITIVE IONS ARE SAMPLED IN SITU BY THE BENNETT RF MASS SPECTROMETER SENSOR WITH ORIFICE ORIENTED INTO DIRECTION OF MOTION. INSTRUMENT MEASURES DIRECTLY ALL IONS PRESENT IN THE MASS RANGE 1-36 ATOMIC MASS UNITS (AMU), INCLUDING
ALL PRINCIPAL IONS ANTICIPATED AT THE NIMBUS ALTITUDE. COMPLETE MASS RANGE IS "SWEPT" OR SAMPLED ONCE EVERY 18 SECONDS,
IN A CONTINUING CYCLE. ION CURRENTS COLLECTED ARE RELATED TO
EQUIVALENT AMBIENT ION CONCENTRATIONS AT THE SENSOR ORIFICE.
THE INSTRUMENT HAS AN ION CURRENT SENSITIVITY OF 5X10\*\*-14 TO
5X10\*\*-9 AMPERES WHICH IS EQUIVALENT TO AN ION CONCENTRATION
SENSITIVITY OF 10 TO 10\*\*6 IONS/CC. EACH ATOMIC MASS UNIT
POSITION IS SAMPLED ONCE EVERY 16 SECONDS, CORRESPONDING TO A
SPATIAL RESOLUTION OF APPROXIMATELY 100 KILOMETERS AND 1 DEG OF
LATITUDE.

| 32. PHENOMENA OBSERVED |           |         |      |           |     |     |      |     |    |  |  |
|------------------------|-----------|---------|------|-----------|-----|-----|------|-----|----|--|--|
| PUSITIVELY             | CHARGED   | THERMAL | IONS | INCLUDING | HT, | OT, | HET, | AND | NT |  |  |
| 33. MEASUREMEN         |           |         |      |           |     |     |      |     |    |  |  |
| 34. PRECISION AN       | DACCURACY |         |      |           |     |     |      |     |    |  |  |
| SEE ITEM 3             |           |         |      |           |     |     |      |     |    |  |  |

| 35. SPECTRAL                   | RANGE         |                        |         |                  |           | 36.           | SPECTRA     | AL RE   | SOL | UTION    |          | CONSTANT                              |
|--------------------------------|---------------|------------------------|---------|------------------|-----------|---------------|-------------|---------|-----|----------|----------|---------------------------------------|
|                                |               |                        |         |                  |           |               |             |         |     |          | 18       | SEC                                   |
| 38. FIELD OF V                 | IEW           |                        | :       | 39. GRO          | UND SWA   | TH            |             |         |     |          |          |                                       |
| 42 44 5 5 5 5                  | ~ <del></del> |                        |         |                  |           |               |             |         |     | <u> </u> |          |                                       |
| 40. ANGULAR RES                | OLUTIO        | 41. SPATIAL            | . HESO  | LUTION           |           |               |             |         |     |          |          |                                       |
| 42. POINTING ACC               | .DAGY         | 42 POINTING            | DATE    |                  | 44. ALT   |               |             |         | AE  | INCLINA  | TION     |                                       |
| 42. POINTING ACC               | JHACY         | 43. FUINTING           | MAIL    |                  |           |               | RCULA       | D       |     |          |          | ETROGRADE                             |
| 46. SPECIAL RE                 | OUR           | EMENTS                 |         |                  | MED       | CI            | RCOLA       | <u></u> | 3(  | J14-31   | ideli ki | LINDGNAUL                             |
| 40. G EGIAE III                |               | - INICIA 10            |         | ····· - 335      | -         |               | ···         |         |     | _ // C   |          |                                       |
| 47. COMPONEN                   | TS            |                        |         |                  |           |               |             |         |     |          |          |                                       |
| BENNET S                       | _             | TROMETER               | TUE     | BE, E            | LECTR     | ON            | ICS         |         |     |          |          | · · · · · · · · · · · · · · · · · · · |
| 48. WEIGHT                     |               | DLUME                  |         |                  | RAGE POW  |               | 51. STAND   | BY POW  | VER | 52. PEA  | K POWER  | 53. MTBF                              |
|                                |               | 0.23 C                 | U FT    |                  | 2 WAT     | TS            |             | -       | 7   | <u></u>  |          |                                       |
| 64. INTERFERENCE               | 55. IN        | MAGNETIC<br>TERFERENCE | 56. NUI | CLEAR<br>FERENCE | 57. INT   | HERM<br>ERFER | AL<br>RENCE | 58. S   | HIE | LDING    |          |                                       |
|                                |               |                        |         |                  |           |               |             |         |     |          |          |                                       |
| 59. CALIBRATI                  | ON            |                        |         | 60. D            | ATA REC   | ov            | ERY ,       |         |     |          |          | OBSERVATION                           |
|                                |               |                        |         | l                |           |               | ·           |         |     | CONT     | INUOU    | <u> </u>                              |
| 62. TELEMETR                   | Y REQ         | UIREMENTS              |         |                  |           |               |             |         |     |          |          |                                       |
| 1                              |               |                        |         |                  |           |               |             |         |     |          |          |                                       |
|                                |               |                        |         |                  |           |               |             |         |     |          |          |                                       |
| 62 ADVANTAG                    | TEC AS        | DIBATATIO              | AIC :   |                  |           |               |             |         |     |          |          |                                       |
| 63. ADVANTAGES AND LIMITATIONS |               |                        |         |                  |           |               |             |         |     |          |          |                                       |
|                                |               |                        |         |                  |           |               |             |         |     |          |          |                                       |
| 64. REFERENC                   | FS            |                        |         |                  |           |               |             |         |     |          | ,        |                                       |
| PRELIMIN                       |               | DATA SH                | CCT     | EOD              | ALT MID I | <u> </u>      | E NO        | 11/     | 1 ( | 270      |          | <u> </u>                              |
| PREEIMIN                       | IANI          | DAIA 30                | EEI     | FUR              | O OFFI FI | 3-            | F P NU      | V • •   | 1,  | 7.1 O •  |          |                                       |
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|                                |               |                        |         |                  |           |               |             |         |     |          |          |                                       |
| 65. HISTORICA                  | L REM         | ARKS                   |         |                  |           |               |             |         |     |          |          |                                       |
|                                |               |                        |         |                  |           |               |             |         |     |          |          |                                       |
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|                      |                   |        | GREENBELT, MD. 2   | .0771   |                   |                           |                    |             |          |                 |
|----------------------|-------------------|--------|--------------------|---------|-------------------|---------------------------|--------------------|-------------|----------|-----------------|
| 1. TITLE             |                   |        |                    |         |                   |                           | 2. /               | ACRONYM     | 3.1      | EXP NO          |
| SATELLITE            | INFRARED SE       | PECT   | ROMETER            |         |                   |                           | Si                 | PS          | $\prod$  |                 |
| (TITLE CONT.         | )                 |        |                    |         |                   |                           | 4 R                | ESUME DATE  |          | 5.<br>VERSION   |
|                      |                   |        |                    |         |                   |                           | 0.9                | 7/01/       |          | 3008            |
| 6. PRINCIPAL IN      | IVESTIGATOR       | 7. OR  | GANIZATION         |         |                   | 8. TI                     | ELEPHO             | NE          |          |                 |
| WARK, DR.            | D.Q.              | NOA    | 1/NESC             |         |                   | 301-735-2000              |                    |             |          |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION         |         |                   | 11. T                     | ELEPHO             | NE          |          |                 |
| HILLEARY             | D.T.              | NOA    | A/NESC             |         |                   | 301                       | L <b>-7</b> 35     | <u>-200</u> | <u> </u> |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | MBER    | 15. START<br>DATE | 16. COMPLETION 17. STATUS |                    |             |          |                 |
|                      |                   |        |                    |         |                   |                           |                    | OPER        | ΔΤΙ      | ONAL            |
| 18. MONITOR          |                   | 19. AG | ENCY               | 20. PGN | OFFICE            | E 21. TELEPHONE           |                    |             |          |                 |
| SCHARDT,             | В.В.              | NASA   | A HDQTRS           | DAZ     | ERN               | 202                       | 2-755              | -232        | 2        | -               |
| 22. VENDOR           |                   |        | 23. LOCATION       |         |                   |                           | 24. FLIGHT<br>DATE | 25. L       | .EAD     | TIME            |
| GULTON IN            | NDUSTRIES         |        | ALBAQUERQUE,       | N.      | MEXICO            | )                         | 04/7               | '0 NA       |          |                 |
| 26. INSTRUMEN        | T TYPE            |        |                    |         |                   |                           |                    |             |          | 27.<br>SECURITY |
| SPECTROME            | TER, 14-CHAN      | INEL   | IR FASTIE-EE       | BERT    | FIXE              | )-GF                      | ATIN               | 1G          |          | UNC             |
| 28. APPLICATIO       | N .               |        |                    |         | 29. SPACE         | CRAF                      | Т                  |             |          |                 |
| MET                  |                   |        |                    |         | NIMBUS            | 5-4                       |                    |             |          | _               |
| 30. PURPOSE          |                   |        |                    |         |                   |                           |                    |             |          |                 |
| PRIMARY-             | TO DETERMINE      | THE    | WORLDWIDE 3        | BDI     | MENSIC            | NAL                       | DIS                | TRUB        | JTI      | ΩN              |
| OF TEMPER            | RATURE, FROM      | THE    | GROUND OR FR       | MOS     | CLOUD             | TOF                       | P TO               | AN A        | LTI      | TUDE            |
|                      |                   |        |                    |         |                   |                           |                    |             |          |                 |

PRIMARY- TO DETERMINE THE WORLDWIDE 3 DIMENSIONAL DISTRUBUTION OF TEMPERATURE, FROM THE GROUND OR FROM CLOUD TOP TO AN ALTITUDE OF 16 TO 19 NM, TO MEASURE SURFACE TEMPERATURE OR THE CLOUD-TOP TEMPERATURE, AND ITS HEIGHT. TO MEASURE THE THREE-DIMENSIONAL DISTRIBUTION OF WATER VAPOR, FROM THE GROUND UP TO ABOUT 6.5 NM.

#### 31. PRINCIPLES OF OPERATION

THE INSTRUMENT, A MODIFICATION OF THE NIMBUS B2 SIRS, IS A FASTIE-EBERT FIXED-GRATING INFRARED SPECTROMETER WITH THE FOL-LOWING FEATURES: (1) A PLANE, LIGHT-COLLECTING MIRROR TO PROVIDE ONE FIXED AND TWO VARIABLE EARTH-VIEWING ANGLES; (2) A BALANCED ROTATING CHOPPING MIPROR WHICH SERVES ALTERNATIVELY TO COLLECT SPACE RADIATION, AND EARTH RADIATION; (3) A SPHERICAL MIRROR OF 12.5-INCH FOCAL LENGTH; (4) A 2.5-INCH WITH 1250 LINES PER INCH DIFFRACTION GRATING; (5) A SET OF 14 EXIT SLITS WITH ASSOCIATED INTERFERENCE FILTERS FOR OPDER LIMITATION, AND 14 WEDGE-IMMERSED OR SIMILAR THERMISTOR BOLOMETERS; AND (6) A BLACKBODY RADIATION SOURCE FOR CALIBRATION PURPOSES. THE 15 MICRON RADIATION DATA IS TRANSFORMED INTO A SINGLE TEMPERATURE-PRESSURE PROFILE BY A MATHEMATICAL INVERSION TECHNIQUE. A SIMILAR RELATED TECHNIQUE YIELDS THE ALTITUDE PROFILE OF WATER VAPOR FROM THE 18 TO 35 MICRON DATA THE 11.1 MICRON DATA COMPARED WITH A BLACKBODY TEMPERATURE CALIBRATION CURVE YIELDS SURFACE OR CLOUD-TOP TEM-PERATURES. THE BANDS MONITORED ARE CENTERED AT 11.12, 13.33, 14.01, 14.16, 14.31, 14.45, 14.76, 14.95, 18.82, 22.91, 23.50, 34.31, 33.11, 35.71 MICRONS. DATA IS ACCUMULATED IN 6 SEC IN-TERVALS TO GIVE PROFILES EACH 50 MILES ALONG THE STRIP.

#### 32. PHENOMENA OBSERVED

IR RADIATION EMITTED FROM THE EARTH'S ATMOSPHERE.

#### 33. MEASUREMENT RANGE

40 TO 190 ERG/SEC/SQ-CM/STERADIAN/WAVE-NO

#### 34. PRECISION AND ACCURACY

TEMPERATURE PLUS-MINUS 1 DEG K, WATER VAPOR TO +-1 PERCENT.

| 35. SPECTRAL RANGE                      | 36. SPECTRAL RESOLU  |                              |
|---|--|------------------------------|
|   | CRONS   0.2 MICRON   | 16 SEC                       |
|   | 9. GROUND SWATH  |                              |
|   | 930 NM BY 130 NM FROM  | 600 NM ALITIUDE              |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESO |  |                              |
| 12.5 DEG 130 NM FRO                     | M 600 NM ALTITUDE  |                              |
| 42. POINTING ACCURACY 43. POINTING RATE |  | NCLINATION                   |
|   | MED CIRCULAR SU  | N-SYNCH RETROGRADE           |
| 46. SPECIAL REQUIREMENTS                |  |                              |
|   |  |                              |
| 47. COMPONENTS                          | ANGELIA CONTRACTOR CON |                              |
| SPECTROMETER, MIRRORS,                  | BOLOMETERS, ELECTRONIC   | \$                           |
| 48. WEIGHT 49. VOLUME                   | 50. AVERAGE POWER 51. STANDBY POWER  |                              |
| 70 LB 2.3 CU FT                         | 30 WATTS   |                              |
| 54. INTERFERENCE 55. MAGNETIC 56. INTER | LEAR 57. THERMAL 58. SHIEL   | DING                         |
| SENSITIVE                               | SENSITIVE  |                              |
| 59. CALIBRATION                         | 60. DATA RECOVERY  | 61. FREQUENCY OF OBSERVATION |
| SEE ITEM 31                             | DELAYED TELEMETRY  | CONTINUOUS                   |
| 62. TELEMETRY REQUIREMENTS              | 1  |                              |
| 15 CHANNELS, ALL SAMPLE                 | D WITHIN 100 MILSEC EV   | ERY 2-8 SECONDS.             |
| 9 BIT ACCURACY                          | O WITHIN TOO MESES EV  |                              |
| 7 DIT ACCORACT                          |  |                              |
| 63. ADVANTAGES AND LIMITATIONS          |  |                              |
| MOVING PARTS                            |  | 3                            |
| MUVING PARTS                            |  |                              |
| 64. REFERENCES                          |  | ;                            |
| 1) GALOPP, D.E., SIRS                   | CHREVETEM DIRECTORY 1  | OPELIMI GENERAL              |
| ELECTRIC CO., PHILADELY                 | 0 3003131EM DIRECTORT (  | #21 COLDREGG. 1. •           |
| METEOROLOGICAL IR INST                  | MIA, PAL, DEG. 1907.TT   | DECEMTED AT 12TH             |
| ANNUAL TECH SYMP OF SPI                 | UMENIS FUR SATELLITES.   | NED DA (EN).                 |
| INTERIM REPORT ON SATE                  | LITE METEODOLOCICAL IN   | CTRIMENTS NACAZEDE           |
| _ :                                     | LITE METEURULUGICAL IN   | STRUMENTS. NASAZERO          |
| PM-6713, JUNE 1967.                     |  |                              |
| 65. HISTORICAL REMARKS                  | <u> </u>   |                              |
|   |  |                              |
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1. TITLE

2. ACRONYM 3. EXP NO
ULTRAVIOLET SOLAR-RADIATION EXPERIMENT

(TITLE CONT.)

4. RESUME DATE VERSION
09/01/72 0005

6. PRINCIPAL INVESTIGATOR 7. ORGANIZATION 8. TELEPHONE

HEATH, DR. D.F. GODDARD SPACE FLT CENTER 301-982-5042

9. CO-INVESTIGATOR 10. ORGANIZATION 11. TELEPHONE

| 12. CONTRACT 13. CONTRACT NU | JMBER   | 14. FLASH INDEX | 15. START<br>DATE | 16. C                  | OMPLETION<br>DATE | 17. STATUS         |               |  |
|------------------------------|---|-----------------|-------------------|------------------------|-------------------|--------------------|---------------|--|
|                              |   |                 |                   |                        |                   |                    | OPERATIONAL   |  |
|                              |   | ENCY            | 20. PGN           | M OFFICE 21. TELEPHONE |                   |                    | NE            |  |
| SCHARDT, B.B.                | NAS   | A HDQTRS        | OA/               | EŔN                    | 20                | 202-755-2322       |               |  |
| 22. VENDOR                   |   | 23. LOCATION    |                   |                        |                   | 24. FLIGHT<br>DATE | 25. LEAD TIME |  |
| ADCOLE CORPORATION           | · <del>····································</del> | WALTHAM, M      | IASS              |                        |                   | 04/6               | 9 NA          |  |
|                              |   |                 |                   |                        |                   |                    | 27.           |  |

26. INSTRUMENT TYPE

SPECTROMETER, 5-CHANNEL OPTICAL-FILTER PHOTODIODE

UNC

28. APPLICATION

MET, ATM-PHYS

NIMBUS 3

#### 30. PURPOSE

PRIMARY-TO DETECT VARIATION OF RELATIVE INTENSITY OF SOLAR FLUX IN 5 SPECTRAL BANDS; \*\*\* SECONDARY-TO MAKE ABSOLUTE MEASUREMENTS OF THE FLUX, TO MEASURE THE RATE OF DECREASE OF FLUX AS THE SATELLITE ENTERS THE EARTH SHADOW NEAR THE POLES, TO MEASURE ATMOSPHERIC OZONE.

#### 31. PRINCIPLES OF OPERATION

THIS EXPERIMENT, SIMILAR TO ONE FLOWN ON NIMBUS D. USES 5 PHOTO-DIODES TO MONITOR THE FLUX FROM THE SUN IN 5 WAVELENGTH REGIONS. THESE REGIONS ARE AT 1216 A(THE HYDROGEN LYMAN ALPHA LINE). 1600 A WITH 150 A WIDTH, 1800 A WITH 300 A WIDTH, 2100 A WITH 450 A WIDTH. AND 2600 A WITH 600 A WIDTH. OPTICAL FILTERS DE-TERMINE THE SHORT WAVELENGTH CUTOFF FOR EACH REGION, AND THE CHOICE OF PHOTOCATHODE MATERIAL DETERMINES THE LONG WAVELENGTH CUTOFF. A SOLAR ASPECT SENSOR GIVES THE ANGLE AT WHICH THE SUN'S RAYS STRIKE THE DIODES WITH 7 BIT ACCURACY. USABLE DATA IS OB-TAINED OVER A 100 DEG FOV. THE RADIDATION INTENSITY IS READ AS THE CURRENT FROM THE PHOTODIODES BY EITHER OF TWO PARALLEL ELEC-TROMETERS WITH FOUR DECADE RANGES. THERE IS AN AUTOMATIC ZERO SETTING DEVICE FOR THE ELECTROMETERS. THEY ARE CALIBRATED USING 5 CONSTANT CURRENTS SUPPLIED BY A RADIOACTIVE SOURCE (AM 241). AN EXPERIMENT CYCLE TAKES 48 SEC INCLUDING CALIBRATION CHECKS, HOUSEKEEPING CHECKS AND SENSOR DATA. EACH SENSOR IS MONITORED FOR 5 SEC PER CYCLE. WHEN THE S/C IS OVER THE POLAR REGIONS THE EARTH'S ATMOSPHERE ATTENUATES THE UV SEEN BY THE SENSORS. THIS OPACITY MEASUREMENT CAN GIVE COARSE MEASURES OF THE OZONE AND MOLECULAR OXYGEN IN THE STRATOSPHERE.

#### 32. PHENOMENA OBSERVED

ULTRAVIOLET SOLAR RADIATION FLUX

#### 33. MEASUREMENT RANGE

SIGNAL CURRENT FROM 0.1 TO 100 NANDAMPS

#### 34. PRECISION AND ACCURACY

ABSOLUTE ACCURACY OF FLUX MEASUREMENTS WITHIN 20 PERCENT

| 35. SPECTRAL RANGE                      |  | 36. SPECTRAL RES   | OLUTION  | 37. TIME (   | CONSTANT   |
|---|--|--|--|--|--|
| 1200. TO 2600.                          | · A  |  | somethy than the second  |  |  |
| 38. FIELD OF VIEW                       | 39. GROUND SWA   |  | 5 : :  | 5 C- (30)   W   M   M   M   M   M   M   M   M   M  |  |
| 100. DEG                                | 1400 NM D  | AM CIRCLE  | FROM 60  | MN OC  | LTITUDE  |
| 40. ANGULAR RESOLUTION 41, SPATIAL RESO |  |  |  |  |  |
| 0.7 DEG 7 NM FROM                       | 600 NM AL  |  |  | a Carrent war to a   | X-1  |
| 42. POINTING ACCURACY 43. POINTING RATE | and the second s |  | 45. INCLINA  |  | - THASH SE   |
|   | MED  | CIRCULAR   | SUN-SYN  | ICH RI   | TROGRADE   |
| 46. SPECIAL REQUIREMENTS                | and the second s | and the second second  | American Recognition of the American Company   | »  |  |
|   | The second section of the second section secti | VALUE OF THE PROPERTY OF THE P |  | Water to the second  |  |
| PHOTODIODE DETECTORS, S                 | TIM ACDECT   | CENCUR, EL   | FETRONI  | rs   | Commence of the commence of th |
| 48. WEIGHT 49. VOLUME                   | 50. AVERAGE POW  |  |  |  | 53. MTBF   |
| 45. WEIGHT                              |  |  | and the second s | was a second second second second second second second second second second second second second second second |  |
| 54. INTERFERENCE 55. IMAGNETIC 56. INTE | UCLEAR<br>RFERENCE 57. INT   | HERMAL<br>REFERENCE 58. SI   | HELDING  | <del></del>  |  |
| SENSITIVE                               |  |  |  |  |  |
| 59. CALIBRATION                         | 60. DATA REC   | T 7. II. W. Lennerson  |  | ay.  | BSERVATION   |
| CONSTANT CURRENTS                       | DELAYED  | TELEMETRY  | 25 N   | AIN PER  | RORBIT   |
| 62. TELEMETRY REQUIREMENTS              |  |  |  |  |  |
| 30 BIT DIGITAL WORD REA                 | D ONCE OV  | ERY SECOND   | AT 4 KE  | BITS P   | ER SEC.  |
|   |  |  |  |  |  |
| 63. ADVANTAGES AND LIMITATIONS          | A TO THE RESIDENCE OF THE PARTY | 1 22 L ·   | Marketon ( marketon and a second   |  |  |
| 03. AUVANTAGES AND LIMITATIONS          | <u></u>  |  |  |  | *  |
|   |  |  |  |  |  |
| 64. REFERENCES                          |  | · · · · · · · · · · · · · · · · · · ·  |  | <u></u>  |  |
| 1) NORMYLE, W.J.: NIMBU                 | S B TO TE  | ST NEW WEAT  | HER SEN  | VSORS,   | IN   |
| AVIATION WEEK AND SPACE                 |  |  |  |  |  |
| 2) PRESS KIT, NIMBUS B.                 | NASA REL   | EASE NO: 68  | -48K, 1  | 1AY 19   | 58.***3)   |
| NIMBUS B COMMAND AND TE                 | ELEMETRY D   | RECTORY, V   | OL 2, E  | XPERI  | MENT SUB-  |
| SYSTEMS. GENERAL ELECTR                 | IC CO. PH  | ILADELPHIA,  | PA. At   | JG. 19   | 67.  |
|   |  |  | nny makanamayana a 🕝 - 😅 24-ah   | ····   | manine very jet i  |
| 65. HISTORICAL REMARKS                  |  | A Tankin Budin   |  | *  | and the state of t |
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TECHNOLOGY EXPERIMENTS

|                           | GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771 |         |                |               |
|---------------------------|--|---------|----------------|---------------|
| 1. TITLE                  |  |         |                | 3. EXP NO     |
| C-BAND PASSIVE REFL       | ECTUR  |         | CPAR           |               |
| (TITLE CONT.)             |  |         | 4. RESUME DATE | 5.<br>VERSION |
| VEN ATTA ARRAY            |  |         | 09/01/7        | 2 2004        |
| 6. PRINCIPAL INVESTIGATOR | 7. ORGANIZATION                                  | 8. TELI | EPHONE         |               |
| STANLEY, H. R.            | NASA WALLOPS STATION                             |         |                |               |
| 9. CO-INVESTIGATOR        | 10. ORGANIZATION                                 | 11. TEL | EPHONE         |               |
|                           |  |         |                |               |

15. START 16. COMPLETION 17. STATUS 14. FLASH INDEX NUMBER 12. CONTRACT 13. CONTRACT NUMBER OPERATIONAL 19. AGENCY 20. PGM OFFICE 21. TELEPHONE 18. MONITOR 202-755-2322 NASA HDOTES OA/ECD ROSENBERG, J.D. 23. LOCATION 24. FLIGHT DATE 25. LEAD TIME 22. VENDOR 01/68 NA

26. INSTRUMENT TYPE

REFLECTOR, C-BAND PASSIVE

UNC

 28. APPLICATION
 29. SPACECRAFT

 GEOD
 GEOS 2

#### 30. PURPOSE

PRIMARY-TO ALLOW A MORE PRECISE CALIBRATION OF THE TRANSPONDER INTERNAL TIME DELAY; USED IN CONJUNCTION WITH THE C-BAND TRANS-PONDER.\*\*\*SECONDARY-TO PROVIDE PASSIVE C-BAND TRACKING CAPABIL-ITIES.

#### 31. PRINCIPLES OF OPERATION

THIS PASSIVE C-BAND REFLECTOR IS INCLUDED ON THE SPACECRAFT IN ORDER TO DETERMINE ACCURATELY THE LONG-TERM EFFECTS OF COM-PONENTS AGING AND THE EFFECTS OF RADIATION UPON THE C-BAND TRANSPONDER SYSTEM. BY TRACKING THE SATELLITE WITH BOTH ACTIVE AND PASSIVE SYSTEMS DURING THE SAME PASS, THE CORRECTIONS TO THE ACTIVE SYSTEM MAY BE ACCURATELY DETERMINED. THE SYSTEM WILL ALSO PERMIT C-BAND TRACKING OF THE SATELLITE ON FREQUENCIES OTHER THAN THE TRANSPONDER INTERROGATE FREQUENCY THUS ENABLING GREATER TRACKING COVERAGE WITHOUT ADDITIONAL DRAIN FROM THE SPACECRAFT POWER SYSTEM.

#### 32. PHENOMENA OBSERVED

RF (C-BAND) TRANSMISSIONS FROM GROUND STATIONS

#### 33. MEASUREMENT RANGE

#### 34. PRECISION AND ACCURACY

BC DB POINT IS 35 DEG FROM MAIN-BEAM DIRECTION

| 35. SPECTRAL      | RANGE                                   |                                       |                                       |         | [3         |             | PECTRA      | L RE                                   | SOLI  | JTION  | 37. TIME  | CONSTANT   | mponen (stage |
|-------------------|---|---------------------------------------|---------------------------------------|---------|------------|-------------|-------------|--|-------|--------|-----------|--|---------------|
| 38. FIELD OF V    | iEW.                                    | т п                                   | Т                                     | 30 CDO  | UND SWAT   | NA          |             |  |       |        | <u></u>   |  | ᅱ             |
| NA                | IEVV                                    |                                       |                                       | NA      | OND SWAT   | <del></del> |             |  |       | ·      |           |  | 4             |
| 40. ANGULAR RES   | OLUTION                                 | 41. SPATIAL                           | RESO                                  |         |            |             | <del></del> | ······································ |       |        |           |  | ᅱ             |
| NA                |   | NA                                    |                                       |         |            |             |             |  |       |        |           |  | 7             |
| 42. POINTING ACCU | RACY 4                                  | <u> </u>                              | RATE                                  |         | 44. ALTIT  | UDE         |             |  | 45. 1 | NCLINA | TION      |  | ٦             |
| NΔ                |   | NA                                    |                                       |         | MED        | EÇ          | CENT        | RIC                                    | н     | GH     | F         | RETROGRAD  | E             |
| 46. SPECIAL RE    | QUIRE                                   | MENTS                                 |                                       |         |            |             |             |  |       |        |           |  | ]             |
|                   |   |                                       |                                       |         |            |             |             |  |       |        |           |  |               |
| 47. COMPONEN      |   |                                       |                                       |         |            |             |             |  |       |        |           | A commence of the second secon |               |
| C-BAND P          |   |                                       | ECT                                   |         |            |             |             |  |       |        | ¥ 000000  | T====  | 긖             |
| 48. WEIGHT        | 49. VO                                  | LUME                                  |                                       |         | RAGE POWER | ~           | STAND       |  | ER    | v ,    | KPOWER    | 53. MTBF   |               |
| 64. INTERFERENCE  | ] ss N                                  | AGNETIC<br>ERFERENCE                  | ca Nu                                 | NON     | 57. THE    |             | NONE        |  |       | NONE   |           | 12 MON   | 4             |
| MERFERENCE        |   |                                       |                                       |         | 37. INTER  | FERENC      | E           | 58. 5                                  | HIEL  | DING   |           |  | 4             |
| 59. CALIBRATION   |   | <u>NE</u>                             | וסא                                   |         | ATA RECO   | WED         |             | \                                      |       | 61 FRE | QUENCY OF | DBSERVATION  | ┪             |
|                   |   | · · · · · · · · · · · · · · · · · · · |                                       | NA      |            | 70 61       |             |  |       |        | PROGRA    |  | 4             |
| 62. TELEMETR      | Y REQU                                  | UREMENTS                              |                                       |         |            |             |             |  |       | 1 43   | TROOKS    |  | ┪             |
| NA                | *************************************** |                                       | · · · · · · · · · · · · · · · · · · · |         |            |             |             |  | -     |        |           |  | 7             |
| •                 |   |                                       |                                       |         | •          |             |             |  |       |        |           |  | ļ             |
|                   |   |                                       |                                       |         |            |             | _           |  |       |        |           |  | ╛             |
| 63. ADVANTAG      | ES AN                                   | LIMITATIO                             | NS                                    |         |            |             |             |  | -     | 15.    |           | 1  | ]             |
| -                 |   |                                       |                                       |         |            |             |             |  |       |        |           |  | 1             |
|                   | <u>.</u>                                |                                       |                                       |         | ·····      |             |             | <u></u>                                |       |        |           |  | 4             |
| 64. REFERENC      |   |                                       |                                       |         |            |             |             |  |       |        |           |  | 4             |
|                   |   |                                       |                                       |         |            |             |             |  |       |        |           | 68.***2)   |               |
|                   |   |                                       |                                       |         |            |             |             |  |       |        |           | R-4035   |               |
|                   |   |                                       |                                       |         |            |             |             |  |       |        |           | RAMETRIC   |               |
| R-4035-5          |   |                                       |                                       |         |            |             |             |  |       |        | -         | PORT NO.   | 1             |
| N-4033-3          | 0-2.                                    | COMMON                                | ICA                                   | 1 TOM 2 | AND 3      | 113         | 1 673       | , .                                    | 140.  | JAN    | 1700      | •  | İ             |
| 65. HISTORICA     | L REMA                                  | ARKS                                  |                                       |         |            |             | 6           |  |       |        |           |  |               |
| GEOS 2 I          | S AL                                    | SO KNOW                               | N AS                                  | S EXP   | LORER      | 36          |             |  |       |        |           |  |               |
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| ļ                 |   |                                       | •                                     |         |            |             |             |  |       |        |           |  |               |
| 1                 |   |                                       |                                       |         |            |             |             |  |       |        |           |  |               |
|                   |   |                                       |                                       |         |            |             |             |  |       |        |           |  | ١             |

| 1. TITLE             |                   |        |                    |         |                   |       | 2                 | ACRONYM            | 3.   | EXP NO          |
|----------------------|-------------------|--------|--------------------|---------|-------------------|-------|-------------------|--------------------|------|-----------------|
| NIMBUS-E.            | /ATS-F AND D      | ΔΤΑ    | ACQUISITION (      | FACI    | LITY              |       | D,                | AFDRL              |      |                 |
| (TITLE CONT.         | )                 |        |                    |         |                   |       | 4. R              | ESUME DATE         |      | 5.<br>VERSION   |
| DATA PEL             | AY LINK           |        |                    |         |                   |       | 0.                | 9/01/              | 72   | 2002            |
| 6. PRINCIPAL IN      | NVESTIGATOR       | 7. OR  | GANIZATION         |         |                   | 8. TI | ELEPHO            | NE                 |      |                 |
| COTE, C.             | E.                | GOD    | DARD SPACE FI      | LT C    | ENTER             | 30    | 1-98              | 2-504              | 2    |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION         |         |                   | 11. T | ELEPHO            | NE                 |      |                 |
| HEFFERNA             | N. P.             | GOD    | DARD SPACE FL      | _T C    |                   |       |                   | 2-504              |      |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | MBER    | 15. START<br>DATE | 16. C | OMPLETION<br>DATE | 17. STA            | TUS  |                 |
|                      |                   |        |                    |         |                   |       |                   | PROP               | OS.  | AL              |
| 18. MONITOR          |                   | 19. AG | ENCY               | 20. PGN | OFFICE            | 21. T | ELEPH             | ONE                |      |                 |
| SCHARDT.             | В.В.              | NAS    | A HDQTRS           | OA/     | ERN               | 20    | 2-75              | 5 <del>-</del> 232 | 2    |                 |
| 22. VENDOR           |                   |        | 23. LOCATION       |         |                   |       | 24 FLIGH<br>DATE  | <sup>7</sup> 25. I | .EAC | TIME            |
|                      |                   |        |                    |         |                   |       | 19                | 74                 |      |                 |
| 26. INSTRUMEN        | T TYPE            |        |                    |         |                   |       |                   |                    |      | 27.<br>SECURITY |
| TRANSCEI             | VER               |        |                    |         |                   |       |                   |                    |      | UNC             |
| 28. APPLICATIO       | N .               |        |                    |         | 29. SPACE         | CRAF  | T                 |                    |      |                 |
| MET, ERS             | P, COMM.          |        |                    |         | NIMBU             | S-F   |                   |                    |      | N               |
| 30. PURPOSE          | •                 |        |                    |         |                   |       |                   |                    |      |                 |

PRIMARY-TO ESTABLISH A TWO-WAY REAL-TIME DATA RELAY LINK BETWEEN NIMBUS-E AND ATS-F TO DEMONSTRATE THE FEASIBILITY OF ELIMINATING LARGE ON-BOARD STORAGE DEVICES FOR FUTURE SPACECRAFT; FEASIBILI-TY OF A RELAY SATELLITE COMMAND LINK; AND FEASIBILITY OF EARTH-ORBITING SATELLITE TRACKING FROM SYNCHRONOUS SATELLITE\*\*\*SECOND-ARY-PROVIDE INCREASED FLEXIBILTY FOR NIMBUS-E EXPERIMENTS.

THE ESSENTIAL ELEMENTS OF THE EXPERIMENTS ARE (1) AN ATS DATA ACQUISITION FACILITY, (2) THE ATS-F SYNCHRONOUS SATELLITE OP-ERATING AS A REPEATER RELAY, AND (3) THE NIMBUS-E EARTH-ORBIT-ING SATELLITE. AN ADDITIONAL ASPECT IS THAT THE REPEATER ON NIMBUS WILL PERMIT DATA ACQUISITION AND RANGE-RATE MEASUREMENTS DIRECTLY BY ANY SPACE TRACKING AND DATA ACQUISITION NETWORK STATION EQUIPPED WITH THE GODDARD RANGE AND RANGE-RATE SYSTEM WHICH IS IN RADIO VIEW OF NIMBUS. THREE SEPARATE FUNCTIONS WHICH CAN BE PERFORMED OVER THE DATA ACQUISITION/ATS/NIMBUS LINK ARE (1) REAL-TIME TRANSMISSION FROM NIMBUS-E TO ATS-F TO THE DATA ACQUISITION FACILITY. (2) SIMULTANEOUS OR DEPENDENT RANGE AND RANGE-RATE TRACKING OF NIMBUS-E BY THE DATA ACQUISI-TION FACILITY THROUGH ATS-F TO NIMBUS-E AND RETURNING TO THE DATA ACQUISITION FACILITY, AND (3) REAL-TIME NIMBUS-E COMMAND OVER A UHF LINK THROUGH ATS-F.

| 32. PHENOMENA OBSERVED     |  |
|----------------------------|--|
| RADIO TRANSMISSION         |  |
| 33. MEASUREMENT RANGE      |  |
| S-BANC RADIO FREQUENCY     |  |
| 34. PRECISION AND ACCURACY |  |
|                            |  |

| 35. SPECTRAL RANGE                                   |                    |         | 36. SPECTRA                                  | AL RES      | OLUTION      | 37. TIME | CONSTANT      |
|--|--------------------|---------|--|-------------|--------------|----------|---------------|
| NA :   |                    |         | NA   |             |              | NA       |               |
| 38. FIELD OF VIEW                                    | 39. GRO            | JND SWA | TH   |             |              |          |               |
| NA 40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION     | NA                 | ·       |  |             |              |          |               |
| NA NA  | 32011011           |         |  |             |              |          |               |
| 42. POINTING ACCURACY 43. POINTING RATI              |                    | 44. ALT | TUDE   |             | 45. INCLI    | NATION   |               |
|  |                    | MED-    | CIRCULA                                      | R           | SUN-S        | YNCH RI  | ETROGRADE     |
| 46. SPECIAL REQUIREMENTS                             |                    |         |  |             |              |          |               |
| AZ COMPONENTO  |                    |         | ·  | <del></del> | <del></del>  | ·        |               |
| 47. COMPONENTS  AMPLIFIERS, MULTIPLEXE               | R. ANI             | FNNA    | <u>.                                    </u> |             | <u> </u>     |          |               |
| 48. WEIGHT 49. VOLUME                                |                    |         | ER 51. STAND                                 | BY POW      | ER 52. PI    | AK POWER | 53. MTBF      |
| 48 LB 1.2 CU F                                       | T 44               | WAT     | TS   |             |              |          |               |
| FF 54 INTERFERENCE 56. INTERFERENCE 56. INTERFERENCE | UCLEAR<br>RFERENCE | 57. INT | HERMAL<br>ERFERENCE                          | 58. SI      | HIELDING     |          |               |
|  | 1                  |         |  | <u> </u>    |              |          | 0005004474044 |
| 59. CALIBRATION                                      | 60. D              | ATA REC | OVERY  |             |              |          | OBSERVATION   |
| 62. TELEMETRY REQUIREMENTS                           |                    |         |  |             | <u> 1 co</u> | NTINUO   | <i>J</i> 3    |
|  |                    |         | <u> </u>                                     |             |              |          |               |
|  |                    |         |  |             |              |          |               |
|  |                    |         |  | +           |              |          |               |
| 63. ADVANTAGES AND LIMITATIONS                       |                    |         |  |             |              |          | i.            |
|  |                    |         |  |             |              |          |               |
| 64. REFERENCES                                       |                    |         |  |             |              |          |               |
| PRELIMINARY DATA SHEET                               | FOR N              | NIMBU   | S-F, NO                                      | ٧.,         | 1970.        | ,        |               |
|  |                    |         |  |             |              |          |               |
|  |                    |         |  |             |              |          |               |
|  |                    |         |  |             |              |          |               |
| ·  |                    |         |  |             |              |          | ,             |
| 65. HISTORICAL REMARKS                               |                    |         | answers dispersions                          | · · ·       |              | ** P     | al garage a   |
|  |                    |         |  |             |              |          | , · • ·       |
|  |                    |         |  |             |              |          |               |
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|                         |            | GREEN   | IBELT, MD      | . 2 | 0771    |                   |        |                    |                  |      |                 |
|-------------------------|------------|---------|----------------|-----|---------|-------------------|--------|--------------------|------------------|------|-----------------|
| 1. TITLE                |            |         |                |     |         |                   |        | 2. /               | ACRONYN          | 3.   | EXP NO          |
| DATA-RELAY LINE         | EXPERIM    | ENT     |                |     |         |                   |        | D/                 | AREL             | E2   | 28              |
| (TITLE CONT.)           |            |         |                |     |         |                   |        | 4. R               | ESUME DAT        | E    | 5.<br>VERSION   |
|                         |            |         |                |     |         |                   |        | 0.0                | 9/01/            | 72   | 0005            |
| 6. PRINCIPAL INVESTIGAT | OR 7. 0    | RGANIZA | TION           |     |         |                   | 8. TE  | LEPHO              | NE               |      |                 |
| COTE, CHARLES           | GO         | DARD    | SPACE          | FL  | T C     | ENTER             | 301    | -982               | 2-504            | .2   |                 |
| 9. CO-INVESTIGATOR      | 10. 0      | RGANIZA | ATION          |     |         |                   |        | ELEPHO             |                  |      |                 |
| HEFFERNAN, PAUL         | GOI        | DDARD   | SPACE          | FL  | T CI    |                   |        |                    | 2-504            |      |                 |
| 12. CONTRACT 13. CONTR  | ACT NUMBER | 14. FL  | ASH INDEX      | NUN | ABER    | 15, START<br>DATE | 16. CC | MPLETION<br>DATE   | 17. STA          | TUS  |                 |
| PROPOSAL                | _          |         |                |     |         |                   |        |                    | PROF             | 05/  | AL              |
| 18. MONITOR             | 19. A      | GENCY   |                |     | 20. PGM | OFFICE            | 21. T  | ELEPHO             | ONE              |      |                 |
| SCHARDT, B.B.           | NA:        | SA HD   | QTRS           |     | OA/     | ERN               | 202    | 2 <del>-</del> 75! | 5 <b>-</b> 232   | 2    | _               |
| 22. VENDOR              |            | 23. LO  | CATION         |     |         |                   |        | 24. FLIGH<br>DATE  | <sup>†</sup> 25. | LEA  | TIME            |
| GODDARD SPACE           | FLT CENTER | R GR    | <u>EENBELT</u> | ,   | MAR'    | YLAND             |        | 12/                | 72               |      |                 |
| 26. INSTRUMENT TYPE     |            |         |                |     |         |                   |        |                    |                  |      | 27.<br>SECURITY |
| DATA RELAY, RE          | AL-TIME S- | -BAND   |                | ,,  |         |                   |        |                    |                  |      | PRO             |
| 28. APPLICATION         |            |         |                |     | 2       | 9. SPACE          | CRAF   | r                  |                  |      |                 |
| ERSP                    |            |         |                |     |         | <u>NIMBU</u>      | S E    |                    |                  |      |                 |
| 30. PURPOSE             |            |         |                |     |         |                   |        |                    |                  |      |                 |
| PRIMARY-TO DEF          | INE AND R  | ESOLV   | E THE T        | E C | HNO     | LOGIC             | AL F   | PROB               | LEMS             | I M  | -               |
| POSED BY A TWO-         | -WAY REAL  | TIME    | DATA R         | EL  | AY I    | LINK              | FROM   | 4 TH               | E NIM            | IBU: | S               |
| SPACECRAFT THRE         |            |         |                |     |         |                   | •      | BAS                | ED DA            | TA   |                 |
| ACQUISITION FA          | CILITY.**  | * SEC   | ONDARY-        | TO  | DE      | MONST             | RATE   | E TH               | E TEC            | HN   | 0-              |

LOGICAL UTILITY OF A COMMAND LINK AND OF TWO-WAY DATA TRANSMIS-AT S-BAND OVER APPROXIMATELY 70% OF THE NIMBUS ORBIT. 31. PRINCIPLES OF OPERATION

THE ELEMENTS OF THE EXPERIMENT ARE: (1) AN ATS DATA ACQUISITION FACILITY (DAF), (2) THE ATS-F SYNCHRONOUS SATELLITE OPERATING AS A REPEATER/RELAY, AND (3) A NIMBUS-E SATELLITE WITH THE FOLLOW-ING EQUIPMENTS: ANTENNA WITH CONTRCL AND DRIVE SYSTEM, GRARR TRANSPONDER, NIMBUS-ATS DATA MULTIPLEXER, AND TWT POWER SIMPLI-FIERS. THE DATA MULTIPLEXER RECEIVES SIGNALS FROM THE ONBOARD EXPERIMENTS, SENSORS, TELEMETRY DEVICES, ETC: THE DATA MULTI-PLEXER TRANSLATES THE SEPARATE INPUT SIGNALS IN FREQUENCY ACCORDING TO A PRESCRIBED FREQUENCY-DIVISION MULTIPLEX (FDM) SCHEME FOR PHASE MODULATION ONTO AN RF CARRIER. THE MODULATED SIGNAL IS FURTHER TRANSLATED IN FREQUENCY TO 2253 MHZ BY THE UP-CONVERTER AND THEN BROUGHT TO AN OUTPUT POWER LEVEL OF ABOUT TEN WATTS BY THE TWT AMPLIFIER. THE TWT FEEDS THE DIRECTIONAL S-BAND ANTENNA. THE SIGNAL TRANSMITTED BY NIMBUS WILL BE RECEIVED AT THE ATS BY THE S-BAND RECEIVER. THE RECEIVED SIGNAL WILL BE TRANSLATED TO AN INTERMEDIATE FREQUENCY, DOWN-CONVERTED BY 450 MHZ, AMPLIFIED TO A POWER LEVEL OF TEN WATTS, AND FED TO AN EARTH-COVERAGE S-BAND ANTENNA FOR TRANSMISSION TO THE DAF.

#### 32. PHENOMENA OBSERVED

DATA FROM ONBOARD EXPERIMENTS, SENSORS, TELEMETRY SYSTEMS, ETC. 33. MEASUREMENT RANGE

S-BAND

34. PRECISION AND ACCURACY

| 35. SPECTRAL RANGE                     |                      |            | 36. SPECTR         | AL RESO  | LUTION    | 37. TIME ( | CONSTANT  |
|--|----------------------|------------|--------------------|----------|-----------|------------|---|
| 2.253                                  | GH                   | <b>7</b> . | NA                 |          |           | NA         |   |
| 38. FIELD OF VIEW                      | 39. GRO              | UND SWA    | \TH                |          |           |            |   |
| NA                                     | NA                   |            |                    |          |           |            |   |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES | OLUTION              |            | ,                  |          |           |            |   |
| NA NA                                  |                      |            |                    |          |           |            |   |
| 42. POINTING ACCURACY 43. POINTING RAT | E                    | 44. ALT    | TUDE               | 45       | . INCLINA | TION       |   |
| 1.0 DEG 0.17 DE                        | G/SEC                | MED        |                    |          |           |            |   |
| 46. SPECIAL REQUIREMENTS               |                      |            |                    |          |           |            | 1000  |
|  |                      |            |                    |          |           |            |   |
| 47. COMPONENTS                         |                      |            |                    |          |           |            |   |
| TRANSPONDER, POWER AMP                 |                      |            |                    |          |           |            |   |
| 48. WEIGHT 49. VOLUME                  | 1                    |            | ER 51. STAND       | BY POWER | 52. PEA   | KPOWER     | 53. MTBF  |
| 48 LB 1.2 CU F                         |                      | 4 WAT      | -                  |          |           |            |   |
|  | IUCLEAR<br>ERFERENCE | 57. INT    | HERMAL<br>RFERENCE | 58. SHII | ELDING    |            |   |
| SOURC/SEN                              |                      | <b>S</b> 0 | URCE               |          |           |            |   |
| 59. CALIBRATION                        |                      |            | OVERY              |          |           |            | BSERVATION  |
| ,                                      | R E ∕                | ALTIM      | E TELEM            | ETRY     | AS        | NEEDED     |   |
| 62. TELEMETRY REQUIREMENTS             |                      |            |                    |          |           |            |   |
| ATS-F NIMBUS E COMMAND                 |                      |            |                    |          |           |            |   |
| NIMBUS-STADAN RANGE, P                 | ANGE F               | RATE,      | AND DA             | TA LI    | VK PR     | OPOSED     | AT 2.2  |
| GHZ AND 1.8 GHZ.                       |                      |            |                    |          |           |            | · · · · · · · · · · · · · · · · · · ·   |
| 63. ADVANTAGES AND LIMITATIONS         |                      |            |                    | ···      |           |            |   |
| THE EXPERIMENT PROVIDE                 |                      |            |                    |          |           |            | E DATA,   |
| HENCE DEPENDENCE ON TH                 | E REC                | DRDER      | S CAN B            | E LES    | SENED     | •          |   |
| 64. REFERENCES                         |                      |            |                    |          |           |            |   |
| 1) COTE, C., ET AL: A                  |                      |            |                    |          |           |            | ENT -   |
| NIMBUS E DATA RELAY LI                 | NK THE               | ROUGH      | ATS-F,             | GSFC     | , MAR     | 68.        |   |
| 1                                      |                      |            |                    |          |           |            |   |
|  |                      |            |                    |          |           |            |   |
|  |                      |            |                    |          |           |            |   |
|  |                      |            |                    | ·        |           |            |   |
| 65. HISTORICAL REMARKS                 |                      |            |                    |          |           |            |   |
|  |                      |            |                    |          |           |            |   |
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|  |                      |            |                    |          |           |            |   |
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| ,                                      |                      |            |                    |          |           |            |   |
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|  |                      |            |                    |          |           |            | •   |
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| 1                                      |                      |            |                    |          |           |            |   |
|  |                      |            |                    |          |           |            |   |

| 1. TITLE             |             |          |         |           |    |         |                   |       | 2                 | ACRONY           | л З. | EXP, N       | 0   |
|----------------------|-------------|----------|---------|-----------|----|---------|-------------------|-------|-------------------|------------------|------|--------------|-----|
| ELECTROS'            | TATIC PR    | OBE      |         |           |    |         |                   |       | E                 | <b>D</b>         |      |              |     |
| (TITLE CONT.         | )           |          |         |           |    | •       |                   |       | 4. Я              | ESUME DA         | ΓE   | 5.<br>VERSIO | N   |
|                      |             |          |         |           |    |         |                   |       | 0.9               | 9/01/            | 172  |              |     |
| 6. PRINCIPAL II      | VESTIGATOR  | 7. OF    | RGANIZA | ATION     |    |         |                   | 8. T  | ELEPHO            | NE               |      |              |     |
| BRACE, L             | . H.        | GO       | DARD    | SPACE     | FI | LT C    | ENTER             | 30    | 1-982             | 2-504            | +2   |              |     |
| 9. CO-INVESTIG       | ATOR        | 10. OI   | RGANIZA | ATION     |    |         |                   | 11. T | ELEPHO            | NE               | -    |              |     |
| FINDLAY,             | J. A.       | GOD      | DARD    | SPACE     | F  | LTC     |                   |       | 1-98              |                  |      |              |     |
| 12. CONTRACT<br>TYPE | 13. CONTRAC | TNUMBER  | 14. FL  | ASH INDEX | NU | MBER    | 15. START<br>DATE | 16 C  | OMPLETION<br>DATE | 17. ST/          | ATUS |              |     |
|                      |             |          |         |           |    |         |                   |       |                   | PRO              | 205  | ΔL           |     |
| 18. MONITOR          |             | 19. A    | GENCY   |           |    | 20. PGA | OFFICE            | 21. 1 | <b>TELEPH</b>     | ONE              |      |              |     |
| SCHARDT,             | В.В.        | NAS      | A HD    | QTRS      |    | OA/     | ERN               | 20    | 2-75              | 5-23             | 22   |              |     |
| 22. VENDOR           |             |          | 23. LC  | CATION    |    |         |                   |       | 24. FLIGH<br>DATE | <sup>7</sup> 25. | LEA  | D TIME       |     |
|                      |             |          |         | _         |    |         |                   |       | 19                | 74               |      |              |     |
| 26. INSTRUMEN        | T TYPE      | ,        |         |           |    |         |                   |       |                   |                  | ` .  | 27.<br>SECUR | Щу. |
| ELECTROS             | TATIC PR    | OBE      |         |           |    |         |                   |       |                   |                  |      | UN           |     |
| 28. APPLICATIO       | N           |          |         |           |    |         | 29. SPACE         | CRAF  | T                 |                  |      |              |     |
| IONOSPHE             | RE AND R    | ADIO PHY | SICS    |           |    |         | NIMBU             | S-F   |                   |                  |      |              |     |
| 30. PURPOSE          |             |          |         |           |    |         |                   |       |                   |                  |      |              |     |

PRIMARY-TO MEASURE THE GLOBAL DISTRIBUTION OF ELECTRON TEMPERA-TURE AND CONCENTRATION AND TO COMBINE THESE WITH THE ION COMPO-SITION MEASUREMENTS ON NIMBUS-F TO STUDY ATMOSPHERIC PROCESSES SUCH AS GLOBAL WIND SYSTEM AT HIGH ALTITUDES.

#### 31. PRINCIPLES OF OPERATION

THE EXPERIMENT EMPLOYS TWO CYLINDBICAL METAL SENSORS 18 INCHES EACH SENSOR IS COMPOSED OF A 9 INCH LONG WIRE COL-LECTOR THAT PROTRUDES FROM A 9 INCH LONG GUARD ELECTRODE THAT IS 0.067 INCHES IN DIAMETER. THE TWO SENSORS ARE LARGELY REDUNDANT AND ARE MOUNTED ON GENERALLY FORWARD-LOOKING SURFACES OF THE SA-TELLITE SO THAT THEY PROTRUDE INTO THE UNPERTURBED PLASMA JUST AHEAD OF THE SATELLITE. A SAWTOOTH VOLTAGE WAVEFORM (TYPICALLY -3 TO +5 VOLTS, 1 CPS) THAT IS APPLIED TO THE COLLECTOR CAUSES VARIATIONS IN THE PLASMA CURRENTS THAT FLOW TO THE PROBE. AMPLITUDE OF THESE CURRENTS IS A MEASURE OF THE ELECTRON CON-CENTRATION IN THE VICINITY OF THE SATELLITE. WHILE THE CURVATURE OF THE CURRENT WAVEFORM DEPENDS UPON THE ELECTRON TEMPERATURE. THE ANALYSIS OF THE DATA IS CARRIED OUT AUTOMATICALLY BY SUIT-ABLE CIRCUITRY WITHIN THE INSTRUMENT COMPUTER ANALYSIS OF THE RAW DATA CAN ALSO BE CARRIED OUT ON THE GROUND TO VERIFY PROPER OPERATION OF THE IN-FLIGHT ANALYSIS. THE INSTRUMENT IS EXPECTED TO RESOLVE THE ELECTRON CONCENTRATION AND TEMPERATURE THROUGHOUT THE ENTIRE ORBIT OF NIMBUS.

#### 32. PHENOMENA OBSERVED

HIGH ALTITUDE ELECTRON ENERGIES AND DISTRIBUTIONS

33. MEASUREMENT RANGE

34. PRECISION AND ACCURACY

| 35. SPECTRAL RANGE      |                      |              |        |          | 36. SPECT  | RAL RE               | SOLU  | TION                                  | 37. TIME   | CONSTANT   |
|-------------------------|----------------------|--------------|--------|----------|--|----------------------|-------|---------------------------------------|--|--|
| 38. FIELD OF VIEW       |                      | 13           | 9. GRO | UND SWA  | TH   |                      |       | · · · · · · · · · · · · · · · · · · · | <u>l</u>   | ****   |
|                         |                      |              | . J.IV |          |  |                      |       | *                                     | <del>Maja sa mana </del> |  |
| 40. ANGULAR RESOLUTION  | 41. SPATIAI          | L RESOL      | UTION  |          |  |                      |       |                                       |  |  |
|                         |                      |              |        |          |  |                      |       |                                       |  |  |
| 42. POINTING ACCURACY 4 | IS. POINTING         | RATE         |        | 44. ALT  | CIRCUL   | A D                  |       | NCLINA                                | paration in him , have the   | TROGRADE   |
| 46. SPECIAL REQUIRE     | MENTS                |              |        | MEUT     | LIKCOL   | 41                   | 1 30  | <u> </u>                              | TON RE   | TROGRADE   |
|                         |                      |              |        |          | <u></u>  |                      |       | Anna and a                            |  |  |
| 47. COMPONENTS          |                      |              |        |          | Andrew Comments  |                      |       |                                       | The second of th           | And the specific process of the second secon |
| COLLECTOR, D            |                      | <u>, ELE</u> |        |          |  |                      |       |                                       | V DOWED  |  |
| 48. WEIGHT 49. VO       | 0.04 C               | II ET        |        | RAGE POW | Ye make the company of the company o | NUBYPO               | MEH : | OZ. FEM                               | K POWER  | 53. MTBF   |
|                         | AGNETIC<br>ERFERENCE | 56. NUC      |        |          | HERMAL<br>ERFERENCE  | 58.                  | SHIEL | DING                                  |  | <u> </u>   |
|                         |                      |              |        |          | . Williams   |                      |       |                                       |  |  |
| 59. CALIBRATION         |                      |              | 60. D  | ATA REC  | OVERY  |                      |       |                                       |  | OBSERVATION  |
| 62 TELEMETRY DECL       | UDEMENTO             |              |        |          | war was the same of the same o |                      |       | I CON.                                | TINUOU   | 15   |
| 62. TELEMETRY REQU      | INEMENIS             |              |        |          |  |                      |       |                                       |  |  |
|                         |                      |              | •      |          |  |                      |       |                                       |  |  |
|                         |                      |              |        | -        |  |                      |       |                                       |  |  |
| 63. ADVANTAGES AND      | LIMITATIO            | NS           |        |          |  | *                    |       |                                       | *  |  |
|                         |                      |              |        |          |  |                      |       |                                       |  |  |
| 64. REFERENCES          |                      |              |        |          |  | wenter of the second |       | Negarine - France                     | •  |  |
| PRELIMINARY             | DATA SH              | EET I        | FOR N  | VIMBU    | S-F, N   | 0V.,                 | 19    | 70.                                   |  |  |
| -,                      |                      |              |        |          | ·  |                      |       |                                       |  |  |
|                         |                      |              |        |          |  |                      |       |                                       |  |  |
|                         |                      |              |        |          |  |                      |       |                                       | Ÿ.   |  |
|                         |                      |              |        |          |  |                      |       |                                       |  |  |
| 65. HISTORICAL REMA     | RKS                  |              |        |          |  |                      |       |                                       |  | 3  |
|                         |                      |              |        |          |  |                      |       |                                       |  |  |
|                         |                      |              |        |          |  |                      |       |                                       |  |  |
|                         |                      |              |        |          |  |                      |       |                                       |  |  |
|                         |                      |              |        |          |  |                      |       |                                       |  |  |
|                         |                      |              |        |          |  |                      |       |                                       |  |  |
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|                         |                      |              |        |          |  |                      |       |                                       |  |  |

| 1. TITLE             |                   |        |                 |    |        |                   |                  | 2. /              | ACRONYM    | 3.   | EXP NO          |
|----------------------|-------------------|--------|-----------------|----|--------|-------------------|------------------|-------------------|------------|------|-----------------|
| ELECTRON             | TEMPERATURE       | PRO    | BE              |    |        |                   |                  | E.                | TP         |      |                 |
| (TITLE CONT.         | 1                 |        |                 |    |        |                   |                  | 4. R              | ESUME DATE |      | 5.<br>VERSION   |
|                      |                   |        |                 |    |        |                   |                  | 0,                | 9/01/      | 72   | 0004            |
| 6. PRINCIPAL II      | NVESTIGATOR       | 7. OR  | GANIZATION      |    |        |                   | 8. T(            | ELEPHO            | NE         |      |                 |
| SPENCER,             | N.W.              | GOD    | DARD SPACE      | FI | LT (   | ENTER             | 30               | 1-98              | 2-504      | 2    |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION      |    |        |                   | 11. T            | ELEPHO            | )NE        |      |                 |
| BRACE, L             | .H.               | GOC    | DARD SPACE      | FI | LT (   |                   |                  |                   | 2-504      |      |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUME | BER    | 14. FLASH INDEX | NU | MBER   | 15. START<br>DATE | 16. <sup>C</sup> | OMPLETION<br>DATE | 17. STA    | rus  |                 |
|                      |                   |        |                 |    |        |                   |                  |                   | POST       | FI   | <u>IGHT</u>     |
| 18. MONITOR          | F                 | 19. AG | ENCY            |    | 20. PG | M OFFICE          | 21. T            | ELEPH             | ONE        |      |                 |
| TEPPER,              | М.                | NAS    | A HDQTRS        |    | OA     | /ERD              | 20               | 2 <b>-</b> 75     | 5-232      | 2    |                 |
| 22. VENDOR           |                   |        | 23. LOCATION    |    |        |                   |                  | 24. FLIGH<br>DATE | ¹ 25. L    | .EAC | TIME            |
|                      |                   |        |                 |    |        |                   |                  | 06/               | 63 NA      |      |                 |
| 26. INSTRUMEN        | IT TYPE           |        |                 |    |        |                   |                  |                   |            |      | 27.<br>SECURITY |
| COUNTER,             | THERMAL-ELE       | CTRO   | N               |    |        |                   |                  |                   |            |      | UNC             |
| 28. APPLICATIO       | N                 |        |                 |    |        | 29. SPACE         | CRAF             | T                 |            |      |                 |
| MET                  |                   |        |                 |    |        | TIROS             | <u>7</u> .       |                   |            |      |                 |
| 30. PURPOSE          |                   |        | <u> </u>        |    |        |                   |                  |                   |            |      | •               |

PRIMARY-TO MEASURE IONOSPHERIC ELECTRON TEMPERATURE AND DENSITY, AND POSITIVE ION DENSITY OF THE PLASMA IN THE VICINITY OF THE SPACECRAFT.

#### 31. PRINCIPLES OF OPERATION

THE TIROS 7 ELECTRON TEMPERATURE PROBE IS SIMILAR TO THE PROBE FLOWN ON EXPLORER 11 AND 22. THE SENSOR CONSISTS OF A 5-INCH GUARD ELECTRODE AND A 9-INCH COLLECTOR OF 0.022-INCH DIAMETER MOUNTED ON THE SPACECRAFT BASEPLATE (PROJECTING INTO THE PLAS-THE GUARD PREVENTS THE COLLECTION OF CURRENT IN THE REGION IMMEDIATELY ADJACENT TO THE SPACECRAFT AND THEREFORE AVOIDS ANY POSSIBLE RELATED DISTURBANCE OF THE MEASUREMENTS. AN APPROPRI-ATE SAW-TOOTH SHAPED VOLTAGE (-3 TO +5 VOLTS) IS APPLIED BETWEEN THE CYLINDRICAL ELECTRODE AND SATELLITE SHELL AND THE RESULTING CURRENT IS MONITORED. MAGNITUDE AND SHAPE OF THE CURRENT CURVE IS DETERMINED BY THE APPLIED VOLTAGE. THE ION AND ELECTRON CON-TENT OF THE SATELLITE. PHOTO EMISSION OF THE ELECTRODE. AND THE AMBIENT ELECTRON AND ION TEMPERATURE. SINCE THE RELATIVE CON-TRIBUTION OF THESE EFFECTS CAN BE EVALUATED, ELECTRON TEMPERA-TURE AND DENSITY, AND POSITIVE ION DENSITY MAY BE DEDUCED FROM ANALYSIS OF THE VOLT-AMPERE CURVES.

# 32. PHENOMENA OBSERVED AMBIENT THERMAL ELECTRONS AND IONS 33. MEASUREMENT RANGE 34. PRECISION AND ACCURACY

| 35. SPECTRAL RANGE                                | pr Str          | 36. SPECTRAL RE  | SOLUTION   | 37. TIME CONSTANT                     |
|---|-----------------|--|--|---------------------------------------|
| NA  |                 | NA   |  |                                       |
| 38. FIELD OF VIEW                                 | 39. GROUND SW   | ATH  | ·  |                                       |
| NA  | NA              |  |  | c                                     |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES            | OLUTION         |  |  |                                       |
| 42. POINTING ACCURACY 43. POINTING RAT            | E 44. ALT       | TITUDE   | 45. INCLINA  | ATION                                 |
| NA NA   | MED             | CIRCULAR   | MEDIUM   |                                       |
| 46. SPECIAL REQUIREMENTS                          | 1,120           | OINGOLAN   | 7,12,010   |                                       |
|   |                 |  |  |                                       |
| 47. COMPONENTS                                    |                 | The second secon |  |                                       |
| GUARD ELECTRODE, COLLE                            | CTOR, POWE      | R SOURCE   |  |                                       |
| 48. WEIGHT 49. VOLUME                             | 50. AVERAGE POW | Marian and a second a second and a second and a second and a second and a second and a second and a second and a second and a second and a second an | NER 52. PEA  | K POWER 53. MTBF                      |
| 2 LB  | 2 WAT           |  |  |                                       |
|   |                 |  | SHIELDING  | CTOOPE DOCUTOES                       |
| 59 CALIBRATION                                    | NSITIVE         | THE CONTRACTOR OF THE CONTRACT |  | CTRODE PROVIDED QUENCY OF OBSERVATION |
|   | 60. DATA RE     |  | All Committee of the Co |                                       |
| PERIODIC RESISTOR MEAS 62. TELEMETRY REQUIREMENTS | I DELATED       | TELEMETRY  | Tron   | TINUOUS                               |
| ANALOG OUTPUT REQUIRES                            | AROUT 50        | HT RESPONS   | F 08 50  | SAMPLES PER                           |
| SECOND DIGITAL WORDS.                             | A0001 J0        | 112 11231 0143   |  | CONTRACT FAIT                         |
| SCOUND DIGITAL WORDS                              |                 |  |  |                                       |
| 63. ADVANTAGES AND LIMITATIONS                    |                 |  |  |                                       |
|   |                 |  |  |                                       |
|   |                 |  | ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,   |                                       |
| 64. REFERENCES                                    | 1.5             |  |  |                                       |
| 1) INSTRUMENTS AND SPACE                          |                 |  |  |                                       |
| *2) MISSION PLAN TIROS                            |                 |  |  |                                       |
| GSFC.***3)SATELLITE AN                            |                 |  |  |                                       |
| NATIONAL SPACE SCIENCE REDDY, B.M.: EARLY ELECT   |                 |  |  |                                       |
| JGR.V.1.DEC 1. 1965.**                            |                 |  |  |                                       |
| 65. HISTORICAL REMARKS                            |                 |  |  |                                       |
| SIMILAR PROBE FLOWN ON                            | FXPLORER        | 11 AND 22.   | <del></del>  |                                       |
| I THE PROPERTY OF                                 | 271 2 2 1 2     |  |  |                                       |
|   |                 |  |  |                                       |
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### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771

| 1. TITLE             |                   |        |                    |         |                   |       |                | 2. ACR     | ONYM   | 3. E | XP NO           |
|----------------------|-------------------|--------|--------------------|---------|-------------------|-------|----------------|------------|--------|------|-----------------|
| FLUXGATE             | MAGNETOMETE       | R      |                    |         |                   |       |                | FMA        | G      |      |                 |
| (TITLE CONT.         |                   |        |                    |         |                   |       |                | 4. RESUM   | E DATE |      | 5.<br>VERSION   |
|                      |                   |        |                    |         |                   |       |                | 09/        | 017    | 72   | 0004            |
| 6. PRINCIPAL IN      | IVESTIGATOR       |        | GANIZATION         |         |                   | 8. TI | ELEPI          | HONE       |        |      |                 |
| COLEMAN,             | DR. P.J.          | UNI    | V OF CALIF A       | T L.    | Α                 |       |                |            |        |      |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION         |         |                   | 11. T | ELEP           | HONE       |        |      |                 |
|                      |                   |        |                    |         |                   |       |                |            |        |      |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | MBER    | 15. START<br>DATE | 16. C | OMPLET<br>DATE | 17         | . STAT | US   |                 |
|                      | NAS5-9570         | -      |                    |         |                   | 1     | 2/6            | 6 0        | PER    | ATI  | ONAL            |
| 18. MONITOR          |                   | 19. AG | ENCY               | 20. PGM | OFFICE            | 21. T | ELEF           | HONE       |        |      |                 |
| BURKE, J             | •R•               | NAS    | A HDQTRS           | OA/     | ECS 1             | 20    | 2-7            | 55-        | 232    | 2    |                 |
| 22. VENDOR           |                   |        | 23. LOCATION       |         |                   |       | 24. FL<br>DA   | IGHT<br>TE | 25. L  | EAD  | TIME            |
| MARSHALL             | LABORATORIE       | S      | TORRANCE, C        | ALIF    | ORNIA             |       | 12/            | 66         | NNA    |      | -               |
| 26. INSTRUMEN        | T TYPE .          |        |                    |         |                   |       |                |            |        |      | 27.<br>SECURITY |
| MAGNETOM             | ETER, BIAXIA      | L. CL  | OSED LOOP FL       | UXGA    | TE                |       |                |            |        |      | UNC             |
| 28. APPLICATIO       | N                 |        |                    | . 2     | 9. SPACE          | CRAF  | T              |            |        |      |                 |
| ATM-PHYS             |                   |        |                    |         | ATS 1             |       |                |            |        |      |                 |
| 30. PURPOSE          |                   |        |                    |         |                   |       |                |            |        |      |                 |

PRIMARY - TO MEASURE THE MAGNETIC FIELD SURROUNDING THE SPACE-CRAFT, BOTH PARALLEL AND PERPENDICULAR TO THE SPIN AXIS AND TO DETECT MAGNETO HYDRO DYNAMIC (MHD) WAVE PROPOGATION WITHIN THE MAGNETOSPHERE.

#### 31. PRINCIPLES OF OPERATION

THIS INSTRUMENT IS SIMILAR TO THAT FLOWN ON OGO-E AND CONSISTS OF TWO CLOSED LOOP. HARMONIC FLUXGATE MAGNETOMETERS AND ASSOCI-THE AXES OF THE 2 MAGNETIC PROBES ARE 90 DEG ATED ELECTRONICS. TO EACH OTHER AND 45 DEG TO THE SPIN AXIS OF THE SPACECRAFT. EACH MAGNETOMETER OUTPUT IS A COMPOSITE VOLTAGE CONSISTING OF A DC VOLTAGE PROPORTIONAL TO THE AMBIENT FIELD PARALLEL TO THE SPIN AXIS AND A SINUSUIDAL VOLTAGE WITH PEAK AMPLITUDE PROPOR-TIONAL TO THE MAGNETIC FIELD PERPENDICULAR TO THE SPIN AXIS. BOTH OUTPUTS ARE FED INTO A DIFFERENTIAL AMPLIFIER AND A SUMMING THE DIFFERENTIAL AMPLIFIER YIELDS A SINUSODIAL SIG-NAL PROPORTIONAL TO THE SUM OF THE AMPLITUDES OF THE TWO INPUT SINUSOIDS. THE OUTPUT OF THE SUMMING AMPLIFIER IS PROPORTIONAL TO THE SUM OF THE 2 DC COMPONENTS. THE INSTRUMENT HAS A SEN-SITIVITY OF 0.05 V PER GAMMA WHERE GAMMA EQUALS 10 TO THE MINUS 5 GAUSS. THE DYNAMIC RANGE IS +-50, 100, OR 200 GAMMA. WITH THE USE OF AN OFFSET FIELD GENERATOR, THE TOTAL DYNAMIC RANGE IS INCREASED TO + 925 GAMMA AND - 675 GAMMA. THE INSTRUMENT AC-CURACY IS +- 0.125 GAMMA WITH A NOISE LEVEL OF 0.1 GAMMA. THE BASIC MAGNETOMETER RESPONSE BANDWIDTH IS FROM DC TO 100 HZ. PRODUCES AN OUTPUT VOLTAGE OF 0 TO + 5.0 VDC.

#### 32. PHENOMENA OBSERVED

MAGNETIC FIELD

#### 33. MEASUREMENT RANGE

-125 TO +350 GAMMA PARALLEL AND -50 TO+50 GAMMA PERP TO S/C AXIS

34. PRECISION AND ACCURACY

SEE ITEM 31

| 35. SPECTRAL RANGE                             |                     | 36          | . SPECTRA     | AL RESOL | UTION   | 37. TIME    | CONSTANT                              |
|--|---------------------|-------------|---------------|----------|---------|-------------|---------------------------------------|
| SEE ITEM 31                                    | <b>V</b>            |             |               | -        |         |             |                                       |
| 38. FIELD OF VIEW                              | 39. GROUN           | ID SWATH    |               | ·        |         |             |                                       |
| NA   | NA .                |             |               |          |         |             | -                                     |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES         | OLUTION             |             |               |          |         |             | · · · · · · · · · · · · · · · · · · · |
| NA NA 42. POINTING ACCURACY 43. POINTING RAT   | - Ta                | 4. ALTITU   |               | I 4E     | INCLINA | TION        |                                       |
| NA   |                     |             |               |          |         |             | OSIGRADE                              |
| 46. SPECIAL REQUIREMENTS                       |                     | 31 1611     | CINCO         | LAN L    | WOA 10  | DIME I      | DOTONABL                              |
| SENSOR, ELECTRONICS                            |                     | <del></del> |               |          |         |             |                                       |
| 47. COMPONENTS                                 |                     |             |               | •        |         |             |                                       |
| 2 MAGNETOMETERS, DIFFER                        | ENTIAL              | AMPLI       | FIER,         | SUMM     | ING A   | MPLIFI      | ER                                    |
| 48. WEIGHT 49. VOLUME                          |                     |             |               |          |         | K POWER     |                                       |
| 4 LB 0.2 CU F                                  | T 4                 | WATTS       |               |          |         |             |                                       |
| 54. INTERFERENCE 55. MAGNETIC 56. INTERFERENCE | UCLEAR<br>ERFERENCE | 57. THERI   | AL<br>RENCE   | 58. SHIE | LDING   |             |                                       |
| SENS   |                     |             |               | REMO     |         |             | ON BOOM                               |
| 59. CALIBRATION                                |                     | A RECOV     |               |          |         |             | DBSERVATION                           |
| INFLIGHT COMMAND                               | REAL                | LTIME       | TELEM         | ETRY     | LCON    | TINUOL      | ISLY                                  |
| 62. TELEMETRY REQUIREMENTS                     |                     |             |               |          |         |             |                                       |
|  |                     |             |               |          |         |             |                                       |
|  |                     |             |               |          |         |             |                                       |
| 63. ADVANTAGES AND LIMITATIONS                 |                     |             |               |          |         | <del></del> |                                       |
| 63. ACVARTAGES ARD CHAITATIONS                 |                     |             |               |          |         |             |                                       |
| •  |                     |             |               |          |         |             |                                       |
| 64. REFERENCES                                 |                     |             | ············· |          |         |             |                                       |
| 1)BARRY, J.D. AND SNAR                         | F. R.C.             | .: Δ F      | ΙUXGΔ         | TE MA    | NE TO   | METER       | FOR THE                               |
| APPLICATIONS TECHNOLOG                         |                     |             |               |          |         |             |                                       |
| SCIENCE VOL. NS-13, NO                         |                     |             |               |          |         |             |                                       |
| REPORT FOR THE ATS PRO                         |                     |             |               |          |         |             |                                       |
|  |                     |             |               |          |         |             |                                       |
| <u> </u>                                       |                     |             |               |          |         | 4           |                                       |
| 65. HISTORICAL REMARKS                         |                     | •           |               |          |         |             |                                       |
|  |                     |             |               |          |         |             |                                       |
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### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771

| 1. TITLE             |                   |        |                                  |         |           |            | 2. /               | CRONYM     | 3. E | XP NO           |
|----------------------|-------------------|--------|----------------------------------|---------|-----------|------------|--------------------|------------|------|-----------------|
| MILLIMETE            | ER WAVE PROPA     | AGAT   | ION/COMMUNICA                    | OITA    | N         |            | MV                 | IPC        | NA   |                 |
| (TITLE CONT.         | )                 |        |                                  |         |           |            | 4. R               | ESUME DATE |      | 5.<br>VERSION   |
| EXPERIMEN            | VT.               |        |                                  |         |           |            | 0.9                | 7017       | 72   | 0004            |
| 6. PRINCIPAL IN      | NVESTIGATOR       | 7. OR  | GANIZATION                       |         |           | 8. T       | ELEPHO             | NE         |      |                 |
| IPPOLITO:            | , L.T.            | GODE   | DARD SPACE FL                    | T C     | ENTER     | 30         | 1-982              | 1/5042     | 2    |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION                       |         |           | 11. T      | ELEPHO             | NE         |      |                 |
| THOMPSON             | , В.              | HUG    | HES AIRCRAFT                     | COM     |           |            |                    |            |      |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NUMBER 15. START |         |           |            | OMPLETION<br>DATE  | 17. STA1   | rus  |                 |
|                      |                   |        |                                  |         |           |            |                    |            |      |                 |
| 18. MONITOR          |                   | 19. AG | ENCY                             | 20. PGN | A OFFICE  | 21. 1      | TELEPHO            | ONE        |      |                 |
| BURKE, J.            | .R.               | NASA   | A HDQTPS                         | OAZ     | ECS_      | 202        | 2-755              | -2322      |      |                 |
| 22. VENDOR           |                   |        | 23. LOCATION                     |         |           |            | 24. FLIGHT<br>DATE | 25. L      | EAD  | TIME            |
|                      |                   |        |                                  |         |           |            |                    |            |      |                 |
| 26. INSTRUMEN        | T TYPE            |        |                                  |         |           |            |                    |            |      | 27.<br>SECURITY |
| TRANSMITT            | TERS 20 GHZ A     | ND 3   | 30 GHZ, 2.5 V                    | TTAL    | TWT       | <b>TYP</b> | E S                |            |      | UNC             |
| 28. APPLICATIO       | N .               |        |                                  |         | 29. SPACE | CRAF       | T                  |            |      | ,               |
| COMM                 |                   |        |                                  |         | ATS-F     |            |                    |            |      |                 |
| 30. PURPOSE          |                   |        |                                  |         |           |            |                    |            |      | ·               |

PRIMARY-TO ASSESS THE POSSIBILITIES OF EARTH/SPACE COMMUNICA-TIONS IN THE KU AND KA BANDS BY DETERMINING ATMOSPHERIC PROPAGA-TION CHARACTERISTICS (ABSORPTION, DISPERSION, FADING, REFRAC-TION, AND COHERENT BANDWIDTH) OF THE BANDS UNDER VARYING WEATHER CONDITIONS.

#### 31. PRINCIPLES OF OPERATION

THE EXPERIMENT CONSISTS OF TRANSMITTING FROM THE SPACECRAFT AT 20 GHZ AND 30 GHZ AND RECEIVING AT VARIOUS GROUND STATIONS THROUGHOUT THE U.S. IN PROPAGATION TESTS EITHER AN UNMODULATED CARRIER OR A CARRIER MODULATED BY NINE EQUAL AMPLITUDE TONES OF 1.5 GHZ BANDWIDTH CAN BE SENT. THE FORMER WILL BE USED TO DETER-MINE MOST CHARACTERISTICS (SEE ITEM 30) WHILE THE LATTER WILL BE USED TO DETERMINE THE COHERENT BANDWIDTH. MEASUREMENTS OF THE AMPLITUDE AND PHASE OF THE RECEIVED SIGNALS WILL BE MADE AT GROUND STATIONS AND FORWARDED ALONG WITH WEATHER DATA TO GSFC FOR DETAILED ANALYSIS OF THE EFFECT OF ADVERSE WEATHER CONDITION ON THE PROPOGATION CHANNELS.SITE & SPATIAL DIVERSITY WILL BE OB-TAINED BY UTILIZING TWO OR MORE RECEIVING STATIONS ON A SINGLE BASE LINE. COMMUNICATIONS TESTS ARE MADE BY MODULATING THE TWO DOWN LINKS EITHER SEPERATELY OR SIMULTANEOUSLY WITH SIGNALS TRAN SMITTED TO THE SATELLITE ON THE 6 GHZ LINK. TYPICAL MODULATIONS INCLUDE ANALOG FM SIGNALS OF SLOW SCAN TV WITH 30 MHZ RF BAND-WIDTH AND MULTICHANNEL VOICE TELEPHONY, AS WELL AS DIGITAL PCM IN BOTH THE NONCOHERENT PCM/FSK/PM MODE AND THE COHERENT PCM/-PSK/PM MODE. THE WELL-DEFINED SATELLITE 4 GHZ DOWN LINK CAN BE USED SIMULTANEOUSLY FOR CALIBRATION.

#### 32. PHENOMENA OBSERVED

PROPAGATION CHARACTERISTICS THRU ATMOSPHERE AT 20 AND 30 GHZ.

#### 33. MEASUREMENT RANGE

| 25 CDECTRAL CANCE  |  |  |
|--|--|--|
| 35. SPECTRAL RANGE   | 36. SPECTRAL RE  |  |
| SEE ITEM 31  | SEE ITEM   | 31 NA  |
|  | GROUND SWATH   |  |
|  | IMB-TO-LIMB  | A company of the comp |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESOLU  | TION   |  |
| 2 CIRC/DEG N/A   |  | T  |
| 42. POINTING ACCURACY 43. POINTING RATE  | 44. ALTITUDE   | 45. INCLINATION  |
| N/A N/A  | GEDSYNC  | O DEG  |
| 46. SPECIAL REQUIREMENTS   |  | E MINTH OFF DAY  |
| OSCILLATOR STABILITY OF  | L PART IN 10 TU TH   | E VINTH PER DAY  |
| 47. COMPONENTS   | ANTENNAS CEASIS  | 246744 066444 4702   |
| TRANSPONDER, HORN & DISH   |  |  |
| the same of the sa | D. AVERAGE POWER 51. STANDBY PO  | WER 52. PEAK POWER 53. MTBF  |
| 85 LB 3. CU FT   | D THERMAL  | 125 WATTS 2 YEAR   |
| S6 MAGNETIC S6 NUCLE/  | <del></del>  | SHIELDING  |
| SOURC/SEN NONE NONE  | SOURC/SEN  |  |
| 59. CALIBRATION  | 60. DATA RECOVERY  | 61. FREQUENCY OF OBSERVATION   |
| SEE ITEM 31  | REALTIME   | MANY HOURS/DAY   |
| 62. TELEMETRY REQUIREMENTS   |  |  |
| RE TRANSMITTER POWERS, FE  | REQUENCY UP CONVER   | TER ".S CURRENTS, TWT  |
| 63. ADVANTAGES AND LIMITATIONS   |  |  |
| ·  | all de la companya de la companya de la companya de la companya de la companya de la companya de la companya d |  |
|  |  |  |
| 64. REFERENCES   | *  |  |
| 1) A PROPOSAL FOR ATS-F  | TILLIMETER WAVE PR   | OPAGATION/COMMUNICAT-  |
| ION EXPERIMENT, NASA/GSFO  |  | State of the state |
| I SKI EKI EKINEMI Y MASAFOSI (   | 24 400031 21413001   |  |
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| 65. HISTORICAL REMARKS   |  |  |
| ATS-5 MWPC USES MANY OF 1  | HE SAME GROUND ST  | ATTONS   |
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| l:                   |                   |           | OARD SPACE FLIC<br>GREENBELT, MD.     |         | TER               |         |            |            |                |
|----------------------|-------------------|-----------|---------------------------------------|---------|-------------------|---------|------------|------------|----------------|
| 1. TITLE             |                   |           |                                       |         |                   |         | 2. 4       | CRONYM     | 3. EXP NO      |
|                      | ATELLITE TO       | SATE      | LLITE TRACK                           | ING     |                   |         | SB         | AND        |                |
| (TITLE CONT.         |                   |           |                                       |         |                   |         |            | ESUME DATE | 5.<br>VERSIO   |
|                      |                   |           |                                       |         |                   |         | 0.9        | /01/7      |                |
| 6. PRINCIPAL II      | NVESTIGATOR       | 7. OR     | GANIZATION                            |         |                   | 8. TE   | LEPHO      | NE         |                |
|                      | J.                | GOD       | DARD SPACE                            | FLT C   | ENTER             | 301     | - 982      | -5042      | 2              |
| 9. CO-INVESTIG       |                   |           | GANIZATION                            |         |                   |         | LEPHO      |            |                |
|                      | J.                |           | DARD SPACE                            | FLT C   | ENTER             | 301     | -982       | -5042      | ·              |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUME |           | 14. FLASH INDEX                       |         | 15. START<br>DATE |         |            | 17. STA1   |                |
| 1172                 |                   |           |                                       |         |                   | 1       |            |            |                |
| 18. MONITOR          |                   | 19. AG    | ENCY                                  | 20. PGN | OFFICE            | 21. T   | ELEPHO     | ONE        |                |
| DILLER, I            | 7. 5.             |           | A HDQTRS                              | OA/     | FŚ                |         |            | -2322      | )              |
| 22. VENDOR           |                   | 1.17.57   | 23. LOCATION                          | 13///   |                   | Ī       | 24. FLIGHT |            | EAD TIME       |
| APL FOR              | ANTENNAS          |           |                                       |         |                   |         |            |            |                |
| 26. INSTRUMEN        |                   |           |                                       |         |                   |         |            |            | 27.<br>SECURIT |
|                      | SPONDER . PWR     | AMPI      | . DIPLEYER                            |         |                   |         |            |            | UNC            |
| 28. APPLICATIO       |                   | 7111      | LY DILLENLK                           | 1:      | 29. SPACE         | CRAF    | r          |            | 10140          |
| GEOD                 |                   | _         |                                       |         | GEOS              |         |            |            |                |
| 30. PURPOSE          |                   |           |                                       |         | GLUS              | <u></u> | · · · · ·  |            |                |
|                      | - PERFORM SAT     | T = T O = | SAT TRACKT                            | NG EY   | DEDIME            | NT      | WITE       | -274       | . E            |
| 1                    | TLY MEASURE S     |           |                                       |         |                   |         |            |            |                |
|                      | FIELD AND TO      |           |                                       |         |                   |         |            |            | ſ              |
|                      |                   |           |                                       |         |                   |         |            |            |                |
| 1                    | EVALUATION OF     |           |                                       | SIAI    | IUNS              | IN U    | MIFI       | EU         |                |
| EARTH-CE             | NTERED REFER      | ENCE      | SYSTEM.                               |         |                   |         |            |            |                |
|                      | OF OPERATION      |           |                                       |         |                   |         |            |            |                |
| 1                    | ND SUBSYSTEM      |           |                                       |         |                   |         |            |            |                |
|                      | ACKING MODE       |           |                                       |         |                   | -       |            |            | ()/            |
| 1                    | DUND-TO-SATE      |           |                                       |         |                   |         |            |            |                |
| 1                    | N IN THE TWO      |           |                                       |         |                   |         |            |            |                |
| EARTH VI             | EWING ANTENN      | A SYS     | STEM SHALL                            | PROVI   | DE HE             | MISP    | HERI       | CAL        |                |
|                      | WITH GAIN GI      |           |                                       |         |                   | 50 D    | EGRE       | ES OF      | -              |
| LOCAL VE             | RTICAL. THE S     | SST       | ANTENNA SYS                           | TEM S   | HALL I            | PROV    | IDE        | +3 DE      | }              |
| GAIN IN              | THE DIRECTION     | N OF      | THE ATS AN                            | YWHER   | E IN              | A BA    | ND C       | )F + (     | )R -           |
| 26 DEGRE             | ES FROM THE I     | LONG      | ITUDE OF AT                           | S. TH   | E MAX             | MUM     | DAI        | LY SC      | HEDULE         |
| OF OPERAT            | TION IS 60-M      | INUT      | E PERIODS P                           | ER OR   | BIT FO            | OR T    | WO S       | SETS (     | )F             |
|                      | NSECUTIVE OR      |           |                                       |         |                   |         |            |            |                |
| Ī                    |                   |           | · · · · · · · · · · · · · · · · · · · |         | •                 | •       |            |            |                |
| 1                    |                   |           |                                       |         |                   |         |            |            | 3              |
|                      |                   |           |                                       |         |                   |         |            |            | ,              |
|                      |                   |           |                                       |         |                   |         |            |            |                |
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|                      |                   |           |                                       |         |                   |         |            |            |                |
| 1                    |                   |           |                                       |         |                   |         |            |            |                |
| 1                    |                   |           |                                       |         |                   |         |            |            |                |
| j .                  |                   |           |                                       |         |                   |         |            |            |                |
| 32. PHENOMEN         | A OBSERVED        |           |                                       |         |                   |         |            |            |                |
|                      |                   |           |                                       |         |                   |         | ·          |            |                |
| 33. MEASUREM         | ENT RANGE         |           |                                       |         |                   |         |            |            |                |
|                      |                   |           |                                       |         |                   |         |            |            |                |
| 34 PRECISION         | AND ACCURACY      |           |                                       |         |                   |         |            |            |                |

0.05 CM/SEC OVER A 10 SEC INTERGRATION INTERVAL.

| 35. SPECTRAL                            | RANGE            |  |                  | <del></del>    |         | 36.   | SPECTRA     | AL RES            | SOL | UTION     | 37. TIME  | CONSTANT    |
|---|------------------|--|------------------|----------------|---------|---|-------------|-------------------|-----|-----------|-----------|-------------|
| 2074.637                                |                  |  | (T)              | MHZ            |         | 1   | NA          |                   |     |           |           |             |
| 38. FIELD OF V                          |                  |  | 3                | 9. GRO         | UND SWA | TH  |             |                   | •   |           |           |             |
|   |                  |  |                  |                |         |   |             |                   |     |           |           |             |
| 40. ANGULAR RES                         | OLUTION          | 4  | RESOL            | UTION          |         |   |             |                   |     |           |           |             |
| NA                                      |                  | NA   |                  |                |         |   |             |                   |     |           |           |             |
| 42. POINTING ACC                        | JRACY 4          | 43. POINTING                                     | RATE             |                | 44. ALT |   |             | $\longrightarrow$ |     | INCLINA   |           |             |
|   |                  |  |                  |                | 921     | KM  | (MEAN       | ,                 | 1 : | ש ט פ     | GREES     |             |
| 46. SPECIAL RE                          | QUIRE            | MENTS  | . Ic. 195 Warman |                |         |   | <del></del> |                   |     |           |           |             |
| 47. COMPONEN                            | TC               | <del> </del>                                     |                  |                |         |   |             |                   |     | g or me   |           |             |
| TRANSPON                                |                  | AND PWR  | ΔΜΡ              | LIFT           | ER      |   |             |                   |     | <u> </u>  |           |             |
| 48. WEIGHT                              | 49. VO           | <del>,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,</del> |                  |                |         | AGE POWER 51. STANDBY POWER 52. PEAK POWER  |             |                   |     |           | 53. MTBF  |             |
| 12                                      |                  | 17.91  |                  |                |         | •   | 3           |                   |     | 36        |           |             |
| 54. INTERFERENCE                        | 56. INT          | AAGNETIC<br>ERFERENCE                            | 54. NUC          | LEAR<br>ERENCE | 57. INT | THERM<br>ERFEF  | AL<br>IENCE | <b>58</b> . S     | HIE | LDING     |           |             |
| SOURC/SE                                | N                |  |                  |                |         |   |             | <u> </u>          |     |           | ***       |             |
| 59. CALIBRATI                           | ON               |  |                  |                | ATA REC |   |             |                   |     | 61. FRE   | QUENCY OF | OBSERVATION |
| NONE                                    |                  |  |                  | <u>  RE</u>    | ALTIM   | E   | TELEM       | ETR'              | Y   | <u>.l</u> |           |             |
| 62. TELEMETR                            |                  |  | CD 14            | TAILE          | C . OF  | <u></u>   | TVED        | 1.00              |     | TDAA      | CDUNDS    | D           |
| 7 PARAME                                |                  |  |                  |                | E F KE  | LE  | TAEK        | LUUI              | •   | IKAN      | SPUNUE    | א           |
| MUUE SIA                                | 105,             | ANTENN   | A MU             | UE.            |         |   |             |                   |     |           |           |             |
| 63. ADVANTA                             | SES AN           | D LIMITATIO                                      | NS               |                |         |   | 8           |                   |     |           |           | •           |
|   |                  |  |                  | EST            | ABLIS   | HE  | D GEO       | DET               | I C | MEAS      | URING     | SYSTEMS.    |
| 10,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, | •••              |  |                  |                |         |   |             |                   |     |           |           |             |
| 64. REFERENC                            |                  |  |                  |                |         | Maria de la Companya |             |                   |     |           |           |             |
| GEOS-C S                                | PACE             | CRAFT E  | XP ER            | IMEN           | TREC    | UI  | REMEN       | TS.               | 000 | CUMEN     | T, RE     | / 1 +       |
| 12 MAY 1                                | 972.             | •  |                  |                |         |   |             |                   |     |           |           |             |
|   |                  |  |                  |                |         |   |             |                   |     |           |           |             |
|   |                  |  |                  |                |         |   |             |                   |     |           |           |             |
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|   | , <del>, ,</del> | 100  |                  |                |         |   |             |                   |     |           |           |             |
| 65. HISTORICA                           | L REM            | ARKS   | • •              |                |         |   |             |                   | •   |           |           |             |
|   |                  |  |                  |                |         |   |             |                   |     |           |           |             |
|   |                  |  |                  |                |         |   |             |                   |     |           |           |             |
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|   |                  |  |                  |                |         |   |             |                   |     |           |           |             |
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| 4                                       |                  |  |                  |                |         |   |             |                   |     |           |           |             |
|   |                  |  |                  |                |         |   |             |                   |     |           |           |             |
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| Į                                       |                  |  |                  |                |         |   |             |                   |     |           |           |             |
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|   |                  |  |                  |                |         |   |             |                   |     |           |           |             |
| 1                                       |                  |  |                  |                |         |   |             |                   |     |           |           |             |
|   |                  |  |                  |                |         |   |             |                   |     |           |           |             |

| GREENBELT, MD. 20771 |                                |        |                    |         |                   |       |                    |              |                 |  |
|----------------------|--------------------------------|--------|--------------------|---------|-------------------|-------|--------------------|--------------|-----------------|--|
| 1. TITLE             |                                |        |                    |         |                   |       | 2. 4               | CRONYM       | 3. EXP NO       |  |
| SOLAR CO:            | SMIC RAY AND                   | TRA    | PPED PARTICLE      | Ē       |                   |       | S                  | RTP          |                 |  |
| (TITLE CONT.         |                                | -      | ··· <u> </u>       |         |                   |       | 4. R               | ESUME DATE   | 5.<br>VERSION   |  |
|                      |                                |        |                    |         | ****              |       |                    | 9/01/        |                 |  |
| 6. PRINCIPAL IN      | VESTIGATOR                     | 7. OR  | GANIZATION         |         |                   | 8. T  | ELEPHO             |              |                 |  |
| MASLEY,              | Δ                              | MC D   | ONNELL DOUGL       | 4 S     |                   |       |                    |              |                 |  |
| 9. CO-INVESTIG       |                                | 10. OR | GANIZATION         |         |                   | 11. T | ELEPHO             | NE           |                 |  |
| *                    | DM, P. R.                      | MC D   | ONNELL DOUGLA      | AS      |                   |       |                    |              |                 |  |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB              |        | 14. FLASH INDEX NU |         | 15. START<br>DATE | 16, C | OMPLETION<br>DATE  | 17. STAT     | US              |  |
| · ,                  |                                |        |                    | PROPOSA |                   |       |                    |              |                 |  |
| 18. MONITOR          |                                | 19. AG | ENCY               | 20. PG  | M OFFICE          | 21. 1 | TE LEPHO           | ONE          |                 |  |
| SCHARDT.             | B.B.                           | NAS    | A HDQTRS           | OA/     | ERN               | 20    | 2-75               | 5-232        | 2.              |  |
| 22. VENDOR           | ·                              |        | 23. LOCATION       |         |                   |       | 24. FLIGHT<br>DATE | 25. L        | EAD TIME        |  |
|                      |                                |        |                    |         |                   |       | 19                 |              |                 |  |
| 26. INSTRUMEN        | T TYPE                         |        | L                  |         |                   |       | <u> </u>           |              | 27.<br>SECURITY |  |
| PROTON-A             | LPHA-PARTICL                   | E TE   | LESCOPE AND        | SPEC    | TROME             | TER   |                    | -            | UNC             |  |
|                      | 28. APPLICATION 29. SPACECRAFT |        |                    |         |                   |       |                    |              |                 |  |
| PARTICLE             | S AND FIELDS                   |        |                    |         | NIMBU             | S-F   |                    |              |                 |  |
| 30. PURPOSE          |                                |        |                    |         |                   | -     |                    | •            |                 |  |
| PRIMARY-             | TO IDENTIFY                    | AND    | DIFFERENTIAL       | LYN     | 1EASUR I          | ΕP    | APTI(              | LEE          | NERGIES         |  |
|                      | •                              |        | ROTONS BETWEE      |         |                   |       |                    |              | ENERGY.         |  |
|                      |                                |        | TICLES 2-250       |         |                   |       |                    |              | ERVALS.         |  |
| (C) ELEC             | TRONS 15 KEV                   | -1 M   | EV IN 5 ENER       | GY I    | NTERV             | ALS   | . (D)              | PRO          | TONS            |  |
|                      |                                |        | MEV***SECOND       |         |                   |       | •                  |              |                 |  |
|                      |                                |        | G RADIATION        |         |                   |       |                    |              |                 |  |
| 31. PRINCIPLES       | OF OPERATION                   |        |                    |         |                   |       |                    |              |                 |  |
| THIS EXP             | ERIMENT IS TO                  | O BE   | CONDUCTED II       | N CC    | NJUNC             | TIO   | N WI               | TH SI        | MULTAN-         |  |
| EOUS OBS             | ERVATIONS OF                   | AN     | IDENTICAL IN       | TERC    | ALIBRA            | ATE   | D DE               | <b>TECTO</b> | R SYS-          |  |
| TEM ON A             | TS-F AND-G I                   | N SY   | NCHRONOUS ORI      | BIT     | AT L=             | 6.6   | . TI               | HE TE        | LESCOPE         |  |
| CONSISTS             | OF THREE SO                    | LID    | STATE DETECT       | DRS.    | THE               | ΟU    | TER (              | DECTE        | CTOR IS         |  |
| A 30 MIC             | RON DOUBLED                    | DIFF   | USED DETECTOR      | R, 1    | THE SE            | CON   | DIS                | 200          | MICRON          |  |
| DOUBLE D             | IFFUSED, AND                   | THE    | BACK DETECT        | OR I    | S A 2             | 000   | MICE               | RON L        | ITHIUM          |  |
| DRIFTED.             | ENERGY AND                     | PAR    | TICLE-TYPE D       | ISCR    | RIMINA            | TIO   | N IS               | ACCO         | MPLISH-         |  |
| ED BY CO             | NSIDERING BO                   | TH T   | HE RANGE AND       | ENE     | RGY L             | oss   | OF '               | THE P.       | ARTICLE         |  |
| IN EACH              | DETECTOR WHE                   | RE I   | T CAUSES ION       | I Z A 1 | TION.             | TH    | E LO               | WEST         | ENERGY          |  |
| PROTON A             | ND ALPHA-PAR                   | TICL   | E CHANNEL IS       | DUE     | TO P              | ART   | ICLES              | s sto        | PPING           |  |
| IN THE F             | IRST DETECTO                   | R.     | THE NEXT HIGH      | HER     | TWO C             | HAN   | NELS               | REQU         | IRE             |  |
|                      |                                |        | OUTER AND CE       |         |                   |       |                    |              |                 |  |
| MAINING              | CHANNELS REQI                  | UIRE   | COINCIDENCE        | BE1     | TWEEN '           | THE   | CEN                | TER A        | ND BACK         |  |
| DETECTOR             | . THE TWO D                    | IREC   | TIONAL PROTO!      | N-AL    | PHA-P             | ART   | ICLE               | TELE         | SCOPES          |  |
| ALLOW TH             | E INVESTIGAT                   | ION    | OF THE MECHA!      | NISM    | 1 BY WI           | HIC   | H LOI              | N ENE        | RGY             |  |
| SOLOR CO             | SMIC RAYS GA                   | IN E   | NTRY INTO ANI      | D PR    | OPAGA             | TE    | WITH:              | IN TH        | E MAG-          |  |
|                      |                                |        | TION OF MAKI       |         |                   |       |                    |              |                 |  |
|                      |                                |        | AND DIRECTION      |         |                   |       |                    |              |                 |  |
|                      |                                |        | ESENTS A UNI       |         |                   |       |                    |              |                 |  |
| INVESTIG             | ATE THIS COM                   |        |                    |         |                   |       |                    |              |                 |  |
| 32. PHENOMEN         | A OBSERVED                     |        |                    |         |                   |       |                    |              |                 |  |
| SEE ITEM             | 30                             |        |                    |         |                   |       |                    |              |                 |  |
| 33. MEASUREM         | ENT RANGE                      |        |                    |         |                   |       |                    |              |                 |  |
| SEE ITEM             | 30                             |        |                    |         |                   |       |                    |              |                 |  |
| 34. PRECISION        | AND ACCURACY                   |        |                    |         |                   |       |                    |              |                 |  |

| 35. SPECTRAL RANGE                                |                      |                 | 36.              | SPECTRA    | AL RES  | OLL  | JTION       | 37. TIME | CONSTANT    |
|---|----------------------|-----------------|------------------|------------|---------|------|-------------|----------|-------------|
| 38. FIELD OF VIEW                                 | 20 000               | UND SWA         | Ti               |            |         |      |             |          |             |
| 36. FIELD OF VIEW                                 | 39. GRO              | UND SWA         | IH               |            |         |      |             |          |             |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES            | OLUTION              |                 |                  |            |         |      |             |          |             |
| NA  |                      |                 |                  |            |         |      |             |          |             |
| 42. POINTING ACCURACY 43. POINTING RATI           | E                    | 44. ALTI        |                  |            |         |      | NCLINA      |          |             |
|   |                      | MED (           | CIF              | CULA       | R       | SU   | N- 5Y!      | NCH RE   | TROGRADE    |
| 46. SPECIAL REQUIREMENTS                          |                      |                 |                  |            |         |      |             |          |             |
| 47. COMPONENTS                                    |                      |                 |                  |            |         |      |             |          | ···         |
| SOLID STATE RADIATION                             | DETEC                | TORS.           | V                | FWIN       | G PC    | PT   | S. Fi       | FCTRO    | NYCS        |
| 48. WEIGHT 49. VOLUME                             |                      | RAGE POWE       |                  |            |         |      |             | K POWER  | 53. MTBF    |
| 16 LB 0.25 CU F                                   | 7 4                  | 4 WATT          |                  |            |         | Ť    | •           |          |             |
|   | IUCLEAR<br>ERFERENCE | 57. 11<br>1NTE  | HERM/<br>RFER    | AL<br>ENCE | 58. SI  | HIEL | DING        |          |             |
|   | NSITI                | <del></del>     |                  |            | <u></u> |      | ·           |          |             |
| 59. CALIBRATION                                   |                      | ATA REC         |                  | RY         |         |      | <del></del> |          | OBSERVATION |
| IN-FLIGHT CALIBRATION  62. TELEMETRY REQUIREMENTS | tl                   | _EMETE          | < <b>Y</b>       |            |         |      | LUN         | TINUOU   | 3           |
| 02. TELEMETRY REQUIREMENTS                        |                      |                 |                  |            |         |      |             |          |             |
|   |                      |                 |                  |            |         |      |             |          |             |
|   |                      |                 |                  |            |         |      |             |          | ļ           |
| 63. ADVANTAGES AND LIMITATIONS                    |                      |                 |                  |            |         |      |             |          |             |
|   |                      |                 |                  |            |         |      |             | 10.8     |             |
|   |                      |                 |                  |            |         |      |             |          |             |
| PRELIMINARY DATA SHEET                            | FOR A                | 1 7 44 73 1 4 6 |                  | - 100      |         | 10   | 70          |          |             |
| PRECIMINARY DATA SHEET                            | FUK I                | A I MBUS        | ) <del>-</del> r | · NO       | V • •   | 19   | 70.         |          |             |
|   |                      |                 |                  |            |         |      |             |          |             |
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|   |                      |                 |                  |            |         |      |             |          |             |
|   |                      |                 |                  |            |         |      |             |          |             |
| 65. HISTORICAL REMARKS                            | · ·                  |                 |                  |            |         |      |             |          | ·           |
|   |                      |                 |                  |            |         |      |             |          |             |
| ·   |                      |                 |                  |            |         |      |             |          |             |
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|   |                      |                 |                  |            |         |      |             |          |             |
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#### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771

|                              |              |        | <u> </u>                              |         |          |        |                    |           |  |                 |
|------------------------------|--------------|--------|---------------------------------------|---------|----------|--------|--------------------|-----------|--|-----------------|
| 1. TITLE                     |              |        |                                       |         |          |        | 2. A               | CRONYM    | 3. E   | XP NO           |
| SOLAR-PRO                    | OTON EXPERIM | ENT    |                                       |         |          |        | SP                 |           |  |                 |
| (TITLE CONT.                 | )            | -      |                                       | -       |          |        | 4. RE              | SUME DATE |  | 5.<br>VERSION   |
|                              |              |        |                                       |         |          |        | 0.9                | 7017      | 72   | 3008            |
| 6. PRINCIPAL IN              | NVESTIGATOR  | 7. OR  | GANIZATION                            |         |          | 8. TE  | LEPHO              | PHONE     |  |                 |
| BOSTROM.                     | C. O.        | APP    | APPLIED PHYSICS LAB 30                |         |          |        |                    | -7100     | )  |                 |
| 9. CO-INVESTIG               | ATOR         | 10. OR | GANIZATION                            |         |          | 11. TE | ELEPHO             | NE        |  |                 |
| WILLIAMS                     | , D. J.      | GOD    | SODDARD SPACE FLT CENTER 301-9        |         |          |        |                    | -982-5042 |  |                 |
| CONTRACT 13. CONTRACT NUMBER |              |        | 14. FLASH INDEX NUMBER 15. START DATE |         |          | 16. CC | MPLETION<br>DATE   | 17. STAT  | US   |                 |
|                              | ESSA ES-86-  | 67     | 57 11/6                               |         |          |        | 66 OPERATIONA      |           |  |                 |
| 18. MONITOR                  |              | 19. AG | ENCY                                  | 20. PGN | OFFICE   | 21. T  | ELEPHO             | NE        |  |                 |
| SIOMKAJL                     | 0, J.        | NES    | C/NOAA                                |         |          | 202    | 2-655              | -4000     | <u>)                                    </u> |                 |
| 22. VENDOR                   |              |        | 23. LOCATION                          |         |          |        | 24. FLIGHT<br>DATE | 25. L     | EAD  | TIME            |
| APPLIED                      | PHYSICS LAB  |        | SILVER SPRIM                          | VG . M  | ARYLA    | ND     | 1/70               | NA NA     |  |                 |
| 26. INSTRUMEN                | T TYPE       |        |                                       |         |          |        |                    |           |  | 27.<br>SECURITY |
| COUNTER,                     | SOLID-STATE  | DET    | ECTOR-ARRAY                           |         |          |        |                    |           |  | UNC             |
| 28. APPLICATIO               | N            |        |                                       | 2       | 9. SPACE | CRAF   | T                  |           |  |                 |
| PART ICLE:                   | S & FIELDS   |        | ITOS-1                                |         |          |        |                    |           |  |                 |
| 30 DIIDDOCE                  |              |        |                                       |         |          |        |                    |           |  |                 |

PRIMARY-TO DETECT SOLAR PROTONS OVER AN EXTENDED PERIOD OF TIME IN THE VICINITY OF THE EARTH FOR: 1. EARLY WARNING OF THE OCCUR-RENCE OF SOLAR-PROTON EVENTS; 2. SYSTEMATIC MONITORING OF PRO-TON INTENSITIES AND SPECTRA: 3. RESEARCH IN SOLAR-TERRESTRIAL PHYSICS.

#### 31. PRINCIPLES OF OPERATION

THE SP CONSISTS OF 6 SOLID STATE DETECTORS. DETECTORS 1,2,3 & 6 ARE MOUNTED ON THE SPACECRAFT SO THAT THE AXES OF THE FOV ARE NEARLY PARALLEL TO THE EARTH'S MAGNETIC FIELD NEAR THE MAGNETIC POLES. DETECTORS 4 AND 5 ARE MOUNTED SUCH THAT THE AXES OF THEIR FOV ARE APPROXIMATELY PERPENDICULAR TO THE EARTH'S MAGNETIC FIELD EVERYWHERE. DETECTORS 1 AND 2 ARE SHIELDED BY HEMISPHERES, THE THICKNESS OF WHICH DETERMINES THE MINIMUM PROTON ENERGY REACHING THE DETECTOR. DETECTOR 1 IS SENSITIVE TO PROTONS ABOVE 60 MEV, AND DETECTOR 2 IS SENSITIVE TO PROTONS ABOVE 30 MEV. DETECTOR 3 IS SENSITIVE TO PROTONS ABOVE 10 MEV AND CONSISTS OF A LITHIUM-DRIFTED SOLID-STATE CUBE-SHAPED DETECTOR SURROUNDED BY AN ALUMINUM SHIELD. DETECTORS 1,2, AND 3 EACH HAVE A FOV OF 2 PI STERADIANS. DETECTORS 5 AND 6 EACH EMPLOY 2 DISK-SHAPED DETECTORS OF THE FULLY-DEPLETED, SURFACE-BARRIER TYPE, AND MEASURE PROTON ENERGIES BETWEEN 0.3 AND 10 MEV. EACH HAS A FOV OF 40 DEGREES. DETECTOR 4, WITH A FOV OF 15 DEGREES. COUNTS ELECTRONS ABOVE 50 KEV AND CONSISTS OF A 700 MICRON-THICK SURFACE-BARRIER DETECTOR. EACH DETECTOR HAS A PREAMPLIFIER-AMPLIFIER-DISCRIMINATOR UNIT ASSOCIATED WITH IT.

#### 32. PHENOMENA OBSERVED

SOLAR PROTONS AND ALPHA-PARTICLES OVER THE POLAR CAPS

#### 33. MEASUREMENT RANGE

SEE ITEM 31

#### 34. PRECISION AND ACCURACY

SEE ITEM 31

| 35. SPECTRAL RANGE                      | 36, SPECTRAL RESOLUTION 37, TIME CONSTANT                   |
|---|---|
| NA                                      | NA  |
| 38. FIELD OF VIEW                       | 39. GROUND SWATH  |
| SEE ITEM 31                             | NA  |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESO |   |
| NA NA                                   |   |
| 42. POINTING ACCURACY 43. POINTING RATE | 44. ALTITUDE 45. INCLINATION                                |
| NA                                      | MED CIRCULAR POLAR NA                                       |
| 46. SPECIAL REQUIREMENTS                |   |
| DETECTORS SHOULD BE MA                  | INTAINED BETWEEN -25 AND +25 DEGREES C.                     |
| 47. COMPONENTS                          |   |
| DETECTORS, AMPLIFIERS,                  |   |
| 48. WEIGHT 49. VOLUME                   | 50. AVERAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF |
| 5 LB   C.1 CU F1                        |   |
|   | CLEAR ST. INTERFERENCE 58. SHIELDING                        |
|   | IS IT IVE   SENSITIVE                                       |
| 59. CALIBRATION                         | 60. DATA RECOVERY 61. FREQUENCY OF OBSERVATION              |
| PRE-FLIGHT CALIBRATION                  | DELAYED AND REALTIME   CONTINUOUS                           |
| 62. TELEMETRY REQUIREMENTS              | NEAS DET HODDS FRAME TIME TO SO STORY                       |
|   | NINE-BIT WORDS, FRAME TIME IS 12 SECS,                      |
|   | 5 BITS/SEC. A DIGITAL ENCODER ASSIMILATES                   |
| THE DATA FOR TRANSMISS                  | UN  |
|   | Y EARLY WARNING OF INCREASE IN SOLAR                        |
| PROTON INTENSITY COULD                  |   |
| 64. REFERENCES                          | DE TRANSMITTED.   |
| 1) BOSTROM. C.O. AND W                  | LLIAMS, D.J.: PROPOSAL FOR SOLAR PROTON                     |
| 1                                       | ATIONAL SAT. APPLIED PHYS LAB, AND GSFC.                    |
|   | ORT FOR THE ITOS SYSTEM, VOL. 1.2. RCA                      |
|   | TRACT NO. NAS 5-9034. 1968.                                 |
|   |   |
|   |   |
| 65. HISTORICAL REMARKS                  |   |
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#### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771

| 1. TITLE             |                   |        |   |      |                 |               | 2. /               | ACRONYM    | 3.  | EXP NO          |
|----------------------|-------------------|--------|---|------|-----------------|---------------|--------------------|------------|-----|-----------------|
| SOLAR-PRO            | OTON EXPERIM      | ENT    |   |      |                 |               | SF                 | 5          |     |                 |
| (TITLE CONT.         | )                 |        |   |      |                 | 711111111111  | 4. R               | ESUME DATE |     | 5.<br>VERSION   |
|                      |                   |        |   |      |                 |               | 09/01/72 000       |            |     | 3008            |
| 6. PRINCIPAL II      | NVESTIGATOR       | 7. OR  | GANIZATION                              |      |                 | 8. TI         | ELEPHO             | EPHONE     |     |                 |
| BOSTROM,             | C. O.             | APPL   | IED PHYSICS                             | LAB  | AB 301-776-710C |               |                    |            |     |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION                              |      |                 | 11. T         | ELEPHO             | NE         |     |                 |
| WILLIAMS             | , D. J.           | GOD    | DARD SPACE FLT CENTER 301-9             |      |                 |               |                    | -982-5042  |     |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | R 14. FLASH INDEX NUMBER 15. START DATE |      |                 |               | OMPLETION<br>DATE  | 17. STA    | rus |                 |
| ESSA ES-86-67        |                   |        | 11/66                                   |      |                 |               | 6 OPERATIONAL      |            |     |                 |
| 18. MONITOR          |                   | 19. AG | GENCY 20. PGM OFFICE                    |      |                 | 21. TELEPHONE |                    |            |     |                 |
| SIOMKAJLO            | ), j.             | NOA    | A/NESC                                  |      |                 | 202-655-4000  |                    |            |     |                 |
| 22. VENDOR           |                   |        | 23. LOCATION                            |      |                 |               | 24. FLIGHT<br>DATE | 25. L      | EAD | TIME            |
| APPLIED I            | PHYSICS LAB       |        | SILVER SPRIM                            | VGS, | MARYLA          | DNA           | 12/7               | 70 NA      |     |                 |
| 26. INSTRUMEN        | T TYPE            |        |   |      |                 |               |                    |            |     | 27.<br>SECURITY |
| COUNTER,             | SOLID-STATE       | DET    | TECTOR-ARRAY                            |      |                 |               |                    |            |     | UNC             |
| 28. APPLICATIO       | N .               |        |   | 1    | 29. SPACE       | CRAF          | T                  |            |     |                 |
| PARTICLES            | S & FIELDS        |        |   |      | NOAA-           | - 1           |                    |            |     |                 |
| 20 BURBOSE           |                   |        |   |      |                 |               |                    | ·····      |     |                 |

PRIMARY-TO DETECT SOLAR PROTONS OVER AN EXTENDED PERIOD OF TIME IN THE VICINITY OF THE EARTH FOR: 1. EARLY WARNING OF THE OCCUR-RENCE OF SOLAR-PROTON EVENTS; 2. SYSTEMATIC MONITORING OF PRO-TON INTENSITIES AND SPECTRA; 3. RESEARCH IN SOLAR-TERRESTRIAL PHYSICS.

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THE SP CONSISTS OF 6 SOLID STATE DETECTORS. DETECTORS 1,2,3 & 6 ARE MOUNTED ON THE SPACECRAFT SO THAT THE AXES OF THE FOV ARE NEARLY PARALLEL TO THE EARTH'S MAGNETIC FIELD NEAR THE MAGNETIC POLES. DETECTORS 4 AND 5 ARE MOUNTED SUCH THAT THE AXES OF THEIR FOV ARE APPROXIMATELY PERPENDICULAR TO THE EARTH'S MAGNETIC FIELD EVERYWHERE. DETECTORS 1 AND 2 ARE SHIELDED BY HEMISPHERES. THE THICKNESS OF WHICH DETERMINES THE MINIMUM PROTON ENERGY REACHING THE DETECTOR. DETECTOR 1 IS SENSITIVE TO PROTONS ABOVE 60 MEV, AND DETECTOR 2 IS SENSITIVE TO PROTONS ABOVE 30 MEV. DETECTOR 3 IS SENSITIVE TO PROTONS ABOVE 10 MEV AND CONSISTS OF A LITHIUM-DRIFTED SOLID-STATE CUBE-SHAPED DETECTOR SURROUNDED BY AN ALUMINUM SHIELD. DETECTORS 1,2, AND 3 FACH HAVE A FOV OF 2 PI STERADIANS. DETECTORS 5 AND 6 EACH EMPLOY 2 DISK-SHAPED DETECTORS OF THE FULLY-DEPLETED. SURFACE-BARRIER TYPE. AND MEASURE PROTON ENERGIES BETWEEN 0.3 AND 10 MEV. EACH HAS A FOV OF 40 DEGREES. DETECTOR 4, WITH A FOV OF 15 DEGREES, COUNTS ELECTRONS ABOVE 50 KEV AND CONSISTS OF A 700 MICRON-THICK SURFACE-BARRIER DETECTOR. EACH DETECTOR HAS A PREAMPLIFIER-AMPLIFIER-DISCRIMINATOR UNIT ASSOCIATED WITH IT.

#### 32. PHENOMENA OBSERVED

SOLAR PROTONS AND ALPHA-PARTICLES OVER THE POLAR CAPS 33. MEASUREMENT RANGE

SEE ITEM 31

34. PRECISION AND ACCURACY

SEE ITEM 31

| 35. SPECTRAL RANGE  | ,              | 36. SPECTRAL RE   | SOLUTION    | 37. TIME (                            | CONSTANT   |
|---|----------------|-------------------|-------------|---------------------------------------|------------|
| NA  |                | NA                |             |                                       |            |
| 38. FIELD OF VIEW   | 39. GROUND SWA | TH                |             |                                       | ·········· |
| SEE ITEM 31 40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION | NA             |                   |             |                                       |            |
| NA NA   | JEOTION        |                   |             |                                       |            |
| 42. POINTING ACCURACY 43. POINTING RATI                   | 44. ALT        | TUDE              | 45. INCLINA | TION                                  |            |
| NA  | MED            | <del></del>       | POLAR       | N                                     | A          |
| 46. SPECIAL REQUIREMENTS                                  |                |                   |             |                                       |            |
| DETECTORS SHOULD BE MA                                    | INTAINED B     | ETWEEN -25        | AVD +2      | 5 DEGR                                | EES C.     |
| 47. COMPONENTS  |                |                   |             |                                       |            |
| DETECTORS, AMPLIFIERS,                                    |                |                   | 1           |                                       |            |
| 48. WEIGHT  |                | R 51. STANDBY POV | VER 52. PEA | RPOWER                                | 53. MTBF   |
|   |                |                   | HIELDING    |                                       | 1 TEAR     |
| <del></del>   | VSITIVE SE     |                   | RIIEEDIIIG  |                                       |            |
| 59. CALIBRATION   | 60. DATA REC   | <del></del>       | 61. FRE     | QUENCY OF C                           | BSERVATION |
| PRE-FLIGHT CALIBRATION                                    | DELAYED        | AND REALT         | IME CON     | TINUOU                                | S          |
| 62. TELEMETRY REQUIREMENTS                                |                |                   |             |                                       |            |
| DATA FRAME COMPRISES 2                                    |                | -                 |             |                                       |            |
| WHICH CORRESPONDS TO 1                                    |                | . A DIGITAL       | L ENCOD     | ER ASS                                | IMILATES   |
| THE DATA FOR TRANSMISS                                    | ION.           |                   |             |                                       |            |
| WITH REAL TIME TELEMET                                    | DV EADLY W     | ADNING OF         | INCOEAC     | E TN C                                | OI A B     |
| PROTON INTENSITY COULD                                    |                |                   | INCKENS     | E IN 3                                | ULAR       |
| 64. REFERENCES  | DL INAII3      |                   |             |                                       |            |
| 1) BOSTROM, C.O. AND W                                    | ILLIAMS. D     | .J.: PROPO        | SAL FOR     | SOLAR                                 | PROTON     |
| MONITOR FOR TIROS OPER                                    | •              |                   |             |                                       | •          |
| ***2) DESIGN STUDY REP                                    | ORT FOR TH     | E ITOS SYS        | TEY, VO     | L. 1.2                                | . RCA      |
| ASTRO-ELECTRONICS, CON                                    | TRACT NO.      | NAS 5-9034        | , 1968.     |                                       |            |
|   |                |                   |             |                                       | -          |
| 65, HISTORICAL REMARKS                                    |                |                   |             | <u></u>                               | -          |
| FLOWN ON ITOS-1.  | <u> </u>       | ·                 |             | · · · · · · · · · · · · · · · · · · · |            |
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GREENBELT, MD. 20771

| 1. TITLE             |                   |                                  |                             |        |                   |               | 2. A              | CRONYM    | 3. ( | EXP NO        |
|----------------------|-------------------|----------------------------------|-----------------------------|--------|-------------------|---------------|-------------------|-----------|------|---------------|
| SOLAR-PR             | OTON EXPERIM      | ENT                              |                             |        |                   |               | SI                | P         |      |               |
| (TITLE CONT.         | )                 |                                  |                             |        |                   |               | 4 RE              | SUME DATE |      | 5.<br>VERSION |
|                      |                   |                                  |                             |        |                   |               | 0,                | 9/01/     | 72   | 0008          |
| 6. PRINCIPAL IN      | NVESTIGATOR       | 7. OR                            | GANIZATION                  |        |                   | 8. TEL        | EPHO              | NE        |      |               |
| BOSTROM,             | C. O.             | APPLIED PHYSICS LAB 301-776-7100 |                             |        |                   |               |                   |           |      |               |
| 9. CO-INVESTIG       | ATOR              | 10. OR                           | GANIZATION                  |        |                   | 11. TE        | LEPHO             | NE        |      |               |
| WILLIAMS             | , D. J.           | GOD                              | DDARD SPACE FLT CENTER 301- |        |                   |               |                   |           |      |               |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER                               | 14. FLASH INDEX NU          | MBER   | 15. START<br>DATE | 16. COM       | PLETION<br>DATE   | 17. STAT  | US   |               |
|                      | ESSA ES-86-       | 67                               |                             |        | 11/6              | 6             |                   | OPER      | AT:  | IONAL         |
| 18. MONITOR          |                   | 19. AG                           | GENCY 20. PGM OFFICE        |        |                   | 21. TELEPHONE |                   |           |      |               |
| SIOMKAJL             | 0, J.             | NOA                              | A/NESC                      |        |                   | 202           | -65               | 5-400     | 0    |               |
| 22. VENDOR           |                   |                                  | 23. LOCATION                |        |                   |               | 24 FLIGHT<br>BATE | 25. L     | EAD  | TIME          |
| APPLIED              | PHYSICS LAB       |                                  | SILVER SPRI                 | NGS,   | MARYL             | AND           | 10/               | 72 NA     |      |               |
| 26. INSTRUMEN        | T TYPE            |                                  |                             |        |                   |               |                   |           |      | SECURITY      |
| COUNTER,             | SOLID-STATE       | DET                              | ECTOR-ARRAY                 |        |                   |               |                   |           |      | UNC           |
| 28. APPLICATIO       | . APPLICATION     |                                  |                             |        |                   | CRAFT         |                   |           |      |               |
| PARTICLE             | S & FIELDS        |                                  |                             | NOAA 2 |                   |               |                   |           |      |               |
| 20 BURBOCE           |                   |                                  |                             |        |                   |               |                   |           |      |               |

PRIMARY-TO DETECT SOLAR PROTONS OVER AN EXTENDED PERIOD OF TIME IN THE VICINITY OF THE EARTH FOR: 1. EARLY WARNING OF THE OCCURRENCE OF SOLAR-PROTON EVENTS; 2. SYSTEMATIC MONITORING OF PROTON INTENSITIES AND SPECTRA; 3. RESEARCH IN SOLAR-TERRESTRIAL PHYSICS.

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#### 32. PHENOMENA OBSERVED

SOLAR PROTONS AND ALPHA-PARTICLES OVER THE POLAR CAPS

33. MEASUREMENT RANGE

SEE ITEM 31

34. PRECISION AND ACCURACY

SEE ITEM 31

| OF COPOTO AL DANIOS  |                       |           | 22 22 22           |          |             | Tag =:::= 2 |            |
|--|-----------------------|-----------|--------------------|----------|-------------|-------------|------------|
| 35. SPECTRAL RANGE   |                       |           | 36. SPECTR         | AL RE    | SOLUTION    | 37. TIME (  | CONSTANT   |
| 38. FIELD OF VIEW  | 39. GROL              | IND CHA   |                    |          |             | <u> </u>    |            |
| SEE ITEM 31  | NA<br>NA              | JAD SWA   | <u> </u>           |          | •           |             |            |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES   |                       |           |                    |          |             |             |            |
| NA NA  |                       |           |                    |          |             |             |            |
| 42. POINTING ACCURACY 43. POINTING RAT   | E                     | 44. ALTI  | TUDE               |          | 45. INCLINA | TION        |            |
| NA   |                       | MED       | CIRCUL             | ΔR       | POLAR       | N           | Δ          |
| 46. SPECIAL REQUIREMENTS   |                       |           |                    |          |             |             |            |
| DETECTORS SHOULD BE MA   | INTAIN                | IED BE    | TWEEN              | -25      | AVD +2      | 5 DEGR      | EES C.     |
| 47. COMPONENTS   |                       |           |                    |          |             |             |            |
| DETECTORS, AMPLIFIERS,   | AND D                 | DISCRI    | MINATO             | RS       |             |             |            |
| 48. WEIGHT 49. VOLUME  | 50. AVER              | RAGE POWE | R 51. STANE        | BY POV   | VER 52. PEA | K POWER     | 53. MTBF   |
| 5 LB 0.1 CU F  |                       | WATT      | - 1                |          |             |             | 1 YEAR     |
|  | NUCLEAR<br>TERFERENCE |           | IERMAL<br>RFERENCE |          | HIELDING    |             |            |
|  | NSITIV                | E SEN     | ISITIVE            | <u> </u> |             |             |            |
| 59, CALIBRATION  |                       | ATA REC   |                    |          |             |             | BSERVATION |
| PRE-FLIGHT CALIBRATION   | DEL                   | AYED      | AND RE             | ALT.     | IME CON     | TINUOU      | S          |
| 62. TELEMETRY REQUIREMENTS   |                       |           |                    |          |             |             |            |
| DATA FRAME COMPRISES 2   |                       |           |                    |          |             |             | ì          |
| WHICH CORRESPONDS TO 1   |                       | 1/3EC.    | A DIG              | LIA      | - ENCOD     | EK A55      | IMILAIES   |
| THE DATA FOR TRANSMISS 63. ADVANTAGES AND LIMITATIONS  | IUN.                  |           |                    |          |             |             |            |
| WITH REAL TIME TELEMET   | DV EAD                | i V LIA   | DALTAIC            | O.E.     | INCOEAC     | E TAI C     | 71 A B     |
| PROTON INTENSITY COULD   |                       |           |                    | UF .     | LINGREAS    | E 114 31    | JLAK .     |
| 64. REFERENCES   | DE IN                 | ANSMI     | 1160.              |          |             |             |            |
| 1) BOSTROM, C.O. AND W   | TILITAN               | IS. D.    | I. PR              | nen      | SAL FOR     | SOLAR       | PROTON     |
| MONITOR FOR TIROS OPER   |                       |           |                    |          |             |             |            |
| ***2) DESIGN STUDY REP   |                       |           |                    |          |             |             |            |
| ASTRO-ELECTRONICS. CON   |                       |           |                    |          | - ·         |             |            |
|  |                       |           |                    | •        |             |             |            |
| <b>\</b>   |                       |           |                    |          |             |             |            |
| 65. HISTORICAL REMARKS   |                       |           |                    |          |             |             | Production |
| FLOWN ON NOAA-1 AND I'   | ros-1                 |           |                    |          |             |             |            |
|  |                       | -         |                    |          |             |             |            |
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| 1. TITLE             |                |        |                   |         |                   |        | 2. A               | CRONYM          | 3. EX    | P NO          |
|----------------------|----------------|--------|-------------------|---------|-------------------|--------|--------------------|-----------------|----------|---------------|
| SOLAR-SC             | IENCE ELEC     | TRON F | LUX EXPERIME      | NT      |                   |        | SS                 | ED              |          |               |
| (TITLE CONT.         | )              |        |                   |         |                   |        | 4. RE              | SUME DATE       | 5.<br>VE | RSION         |
| ELECTRON             | COUNTER        |        |                   |         |                   |        | 0.9                | 7/01/           |          | 004           |
| 6. PRINCIPAL IN      | VESTIGATOR     | 7. OR  | GANIZATION        |         |                   | 8. T£  | LEPHO              | NE              |          |               |
| BOSTROM,             | C.O.           | APL    | -JOHNS HOPKI      | NS U    | NIV               | 30     | 1-776              | <del>-710</del> | 3        |               |
| 9. CO-INVESTIG       | ATOR           | 10. OR | GANIZATION        |         |                   | 11. T  | ELEPHO             | NE              |          |               |
|                      |                |        |                   |         |                   |        |                    |                 |          |               |
| 12. CONTRACT<br>TYPE | 13. CONTRACT N | UMBER  | 14. FLASH INDEX N | UMBER   | 15. START<br>DATE | 16. CC | OMPLETION<br>DATE  | 17. STAT        | US       |               |
|                      |                |        |                   |         |                   | T      |                    | OPERA           | CITA     | NAL           |
| 18. MONITOR          |                | 19. AG | ENCY              | 20. PGM | OFFICE            | 21. T  | ELEPHO             | NE              |          |               |
| ROSENBER             | G, J.D.        | NAS    | A HDQTRS          | OA/     | ECD               | 20     | 2-755              | -232            | 2        |               |
| 22. VENDOR           |                |        | 23. LOCATION      |         | •                 |        | 24. FLIGHT<br>DATE | 25. L           | EAD T    | ME            |
| APL-JOHN             | S HOPKINS      | UNIV   | SILVER SPR        | NG.     | MD.               |        | 01/6               | 8 NA            |          |               |
| 26. INSTRUMEN        | T TYPE         |        |                   |         |                   |        |                    |                 |          | 7.<br>ECURITY |
| COUNTER,             | ELECTRON       | MULTIP | LIER PARTICE      | Ε;      | X-AXI             | S MA   | AGNET              | OMETE           |          | UNC           |
| 28. APPLICATIO       | N              |        |                   | 2       | 9. SPACE          | CRAF   | T                  |                 |          |               |
| PART-FLD             |                |        |                   |         | GEOS              | 2      |                    |                 |          |               |
| 30. PURPOSE          |                |        |                   |         |                   |        |                    |                 |          |               |

PRIMARY-TO MEASURE THE FLUX OF PRECIPITATING ELECTRONS IN THE EARTH'S ATMOSPHERE.

#### 31. PRINCIPLES OF OPERATION

THE SOLAR SCIENCE ELECTRON DETECTOR (SSED) IS AN INSTRUMENT TO MEASURE THE FLUX OF PRECIPITATING ELECTRONS USING ELECTROSTATIC FOCUSING TO DEFINE THE ENERGY INTERVAL AND AN ELECTRON MULTIPLI-ER (BENDIX CHANNELTRON) AS A PARTICLE DETECTOR. THE MAGNETIC PHENOMENA ARE MEASURED WITH THE X-AXIS MAGNETOMETER. THE OUTPUT IS FILTERED AND AMPLIFIED BY A FACTOR OF 100. THE HALF-POWER POINTS ON THE FILTER ARE AT 0.03 HZ AND 3 HZ. AFTER AMPLIFICA-TION THE FULL SCALE TELEMETRY READING IS +- 500 GAMMA WITH A SENSITIVITY OF 5 GAMMA. THE PARTICLE AND MAGNETOMETER DATA ARE SUBCOMMUTATED WITHIN THE SSED PACKAGE SO THAT ONLY ONE CHANNEL OF SATELLITE ANALOG TELEMETRY IS USED. THE 2 OUTPUTS ARE SAM-PLED ALTERNATELY AS PROGRAMMED. PARTICLE DATA ARE OBTAINED ONLY ON PASSES WITHIN VIEW OF THE APL COMMAND STATION. SINCE THE SPACECRAFT IS STABILIZED TO WITHIN ABOUT 20 DEG OF ZENITH AND THE INSTRUMENT COLLIMATOR ADMITS ONLY PARTICLES WITHIN ABOUT 13 DEG OF THE AXIS, PARTICLES WITH LOCAL PITCH ANGLES BETWEEN O AND 33 DEG WILL BE SAMPLED.

#### 32. PHENOMENA OBSERVED

PRECIPITATING ELECTRONS WITH LOCAL PITCH ANGLES FROM 0 TO 33 DEG
33. MEASUREMENT RANGE

33. MEASUNEMENT NAME

FLUX FROM 10 THOUSAND TO 10 BILLION ELECTRONS/SEC/SQ CM/STER
34. PRECISION AND ACCURACY

MAGNETIC PHENOMENA TO PLUS OR MINUS 5 GAMMA.

| 35. SPECTRAL RANGE                                     |                  | 36. SPECTRA  | L RESOLU  | JTION   | 37. TIME    | CONSTANT    |
|--|------------------|--|---|---------|-------------|-------------|
| 4. TO 13.  | KEV              | NA   |   |         |             |             |
|  | . GROUND SWA     | TH   |   |         |             | <u> </u>    |
| 33. DEG N<br>40. ANGULAR RESOLUTION 41. SPATIAL RESOLU |                  |  |   |         |             |             |
| 33. DEG NA   | J I (UN          |  |   |         |             | <u></u>     |
| 42. POINTING ACCURACY 43, POINTING RATE                | 44. ALTI         | TUDE   | 45, 1   | NCLINA  | TION        |             |
|  | MED              | AND THE PERSON NAMED IN COLUMN TWO IS NOT THE OWNER. | राट मा  | GH      | R           | ETRUGRADE   |
| 46. SPECIAL REQUIREMENTS                               |                  |  |   |         |             |             |
| 47. COMPONENTS   |                  | According to the second                              |   |         |             |             |
| ELECTRON MULTIPLIER, X-A                               | XIS MAGNI        |  |   |         |             |             |
| 48. WEIGHT 49. VOLUME                                  | 50. AVERAGE POWE | R 51. STAND  | BY POWER  | 52. PEA | KPOWER      | 53. MTBF    |
| 54. INTERFERENCE 55. INTERFERENCE 56. INTERFER         | AR 57 T          | HERMAL<br>RFERENCE                                   | 58. SHIEL   | DING    |             | <u></u>     |
|  | ITIVE INTE       | RFERENCE   | JO. SHIEL   | DING    | <del></del> |             |
| 59. CALIBRATION  | 60. DATA REC     | OVERY  | ,, , <del>,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,</del> | 61. FRE | QUENCY OF   | OBSERVATION |
|  | DELAYED          | سيستد حسنسا يات                                      | TRY   | AS I    | PROGRA      | MMED        |
| 62, TELEMETRY REQUIREMENTS                             |                  |  |   |         |             |             |
|  |                  |  |   |         |             |             |
| 63. ADVANTAGES AND LIMITATIONS                         |                  | <u> </u>   |   |         |             |             |
| ELECTRON SHEATH NEAR SPA                               | CECRAET          | NTEREC   | SEC MI  | TH F    | YP_         |             |
| ELECTRON SHEATH NEAR SPA                               | CEURAFI          | LNIENTE  | CO MI   | 111 5.  | AF •        |             |
| 64. REFERENCES   |                  |  | *   |         | *           |             |
| 1) NASA PRESS KIT FOR GED                              |                  |  |   |         |             |             |
| PLAN OF OPERATIONS FOR T                               |                  |  |   |         | ORT NO      | .R-4035-    |
| 45-2. COMMUNICATIONS AND                               | SYSTEMS          | INC.,  | JCI. I  | 967.    |             |             |
|  |                  |  |   |         |             |             |
|  |                  |  |   |         |             |             |
| 65. HISTORICAL REMARKS                                 |                  | . 6  |   |         |             |             |
| GEOS 2 IS ALSO KNOWN AS                                | EXPLORER         | 36.  |   |         |             |             |
| ·  |                  |  |   |         |             |             |
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|                               |                   |  | GREENBE                                 | LT, MD.                                | 20771  |                   |       |                    |            |              |                 |
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| 1. TITLE 2. ACRONYM 3. EXP NO |                   |  |   |  |        |                   |       |                    |            |              |                 |
| TROPICAL                      | WIND, ENERG       | Y COI  | VERSIC                                  | N AND                                  | REF    | ERENC             | E     | TV                 | ECRL       |              |                 |
| (TITLE CONT.                  |                   |  | •                                       |  |        |                   |       | 4. RI              | ESUME DATE | 5.<br>V      | ERSION          |
| LEVEL                         |                   |  |   |  |        |                   |       | 0.9                | /01/7      | '2 Ö         | 002             |
| 6. PRINCIPAL IN               | NVESTIGATOR       | 7. OR  | GANIZATIO                               | N                                      |        |                   | 8. TI | LEPHO              | NE         |              |                 |
| KELLOG, V                     | N. W.             | NAT.   | . CEN.                                  | FOR A                                  | TMOS   | S. RES            |       |                    |            |              |                 |
| 9. CO-INVESTIG                | ATOR              | 10. OR   | GANIZATIO                               | N                                      |        |                   | 11. T | ELEPHO             | NE         |              |                 |
| SOUMI, V.                     |                   |  | /ERSITY                                 | OF W                                   | ISC    | NOSN              | L     |                    |            |              |                 |
| 12. CONTRACT<br>TYPE          | 13. CONTRACT NUME | ER   | 14. FLASH                               | INDEX N                                | UMBER  | 15. START<br>DATE | 16. C | OMPLETION<br>DATE  | 17. STAT   | US           |                 |
|                               |                   |  |   |  |        |                   |       |                    | PROPO      | SAL          |                 |
| 18. MONITOR                   |                   | 19. AG   | ENCY                                    |  | 20. PG | M OFFICE          | 21. T | ELEPHO             | ONE        |              |                 |
| SCHARDT,                      | B.B.              | NAS  | A HDQTR                                 |  | DA/    | <u> /ERN</u>      | 203   |                    | -2322      |              |                 |
| 22. VENDOR                    |                   |  | 23. LOCAT                               | ION                                    |        |                   |       | 24. FLIGHT<br>DATE | 25. L      | EAD T        | IME             |
|                               |                   | A100-100 A 1 | <u> </u>                                | <u> </u>                               |        |                   |       | 197                | <u>'4</u>  |              |                 |
| 26. INSTRUMEN                 |                   |  |   |  |        |                   |       |                    |            |              | 27.<br>SECURITY |
| RECEIVER                      |                   |  |   |  |        |                   |       |                    |            |              | UNC             |
| 28. APPLICATIO                | N                 |  |   |  |        | 29. SPACE         |       | T                  |            |              |                 |
| MET                           |                   |  |   |  |        | NIMBU             | S-F   |                    |            |              |                 |
| 30. PURPOSE                   |                   |  | ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, |  |        | · · · ·           |       |                    |            |              |                 |
|                               | TO DETERMINE      |  |   |  |        |                   |       |                    | AT AE      | BOUT         |                 |
|                               |                   |  | rropics                                 |  |        | -LATIT            | JDE S | SIN                | THE S      | OUT          | 'H-             |
|                               | SPHERE***SEC      |  |   |  |        | MICAL             |       |                    | TIONS      |              | •               |
|                               | R TROPOSPHER      |  |   |  |        |                   |       |                    |            |              |                 |
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|                               | OF OPERATION      |  |   |  |        |                   |       |                    |            |              |                 |
| THE OBJEC                     |                   |  |   |  |        |                   |       |                    |            |              |                 |
|                               |                   |  | ETRIEVA                                 |  |        |                   |       |                    | SSARY      |              |                 |
| MUNICATIO                     |                   |  | JCTION                                  |  |        |                   | WI    |                    | TERM       |              | THE             |
| LOCATION                      |                   |  | TO AN                                   |  |        |                   |       |                    | LEAST      |              |                 |
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| PACKAGES                      | IS A RANDOM       |  |   |  |        |                   | WHE   |                    | HE PO      |              |                 |
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|                               | SMITTED SIGN      |  |   |  |        | TH TH             |       |                    | ROM        |              |                 |
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|                               | ATELLITE WILI     |  |   |  |        |                   |       |                    |            |              |                 |
|                               | DMLY TRANSMI      |  |   |  |        |                   |       |                    |            |              |                 |
|                               | AND TIMES         |  |   |  |        |                   |       |                    |            |              |                 |
|                               | Y POLARIZED       |  |   |  |        |                   |       |                    |            |              |                 |
|                               | ILL HAVE A N      |  |   |  |        |                   |       |                    |            |              |                 |
|                               | KHZ. IT WI        |  |   |  |        |                   |       |                    |            |              | ,               |
|                               | AND DIRECTLY      |  |   |  |        |                   |       |                    | ECRAF      | T-           |                 |
| DEKIVED I                     | REFERENCE TO      | NE AL  | ND THE                                  | NIMBU                                  | S CL   | OCK S             | I GN/ | aL.                |            |              |                 |
| 32. PHENOMENA                 |                   | A  |   | ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, | , ,    |                   |       |                    |            |              |                 |
| 33. MEASUREM                  | SNALS FROM B      | ALLU(  | JN2                                     |  |        |                   |       |                    |            | <del>,</del> |                 |
|                               | EN I KANGE        | •  |   |  |        |                   |       |                    |            | <u> </u>     |                 |
| V HF                          | AND ACCURACY      |  |   |  |        |                   |       |                    |            |              |                 |

SEE ITEM 31

| 35. SPECTRAL RANGE 36. SPECTRAL RESOLUTION 37. TIME CONSTANT |                                       |                     |             |                   |        |   |      |           |        |        |         |                 |             |     |
|--|---------------------------------------|---------------------|-------------|-------------------|--------|---|------|-----------|--------|--------|---------|-----------------|-------------|-----|
| 400 MHZ  |                                       |                     |             |                   |        |   |      |           |        |        |         |                 |             |     |
| 38. FIELD OF VI  | EW                                    |                     |             | 39. G             | ROUNI  | D SWAT                                  | ГН   |           |        |        |         | •               |             |     |
| NA   | · · · · · · · · · · · · · · · · · · · | [ <b></b>           |             | NA                |        |   |      |           |        |        |         |                 |             |     |
| 40. ANGULAR RESO   | LUTION                                | <del></del>         | AL RES      | DLUTI             | ON     |   |      |           |        |        |         |                 |             | -   |
| NA<br>42. POINTING ACCU                                      | BACVI A                               | NA<br>BOINTIN       | C PATE      |                   | TAA    | . ALTIT                                 |      | É         | г      | AF '   | NCLINA  | TION            |             |     |
|  | NACT 4                                | S. FUINTIN          | IN NAIL     | •                 |        |   |      | CUL AF    |        |        |         | NCH RE          | TRUCP       | ADE |
| 46. SPECIAL RE   | QUIRE                                 | MENTS               |             |                   | [ (**) | <u> </u>                                | I P  | CULAR     | ·      | J. (1) | 311     | AOIL WE         | . 11 00 01  | 702 |
|  |                                       |                     | <del></del> |                   |        | · - · - · - · - · · · · · · · · · · · · |      |           |        |        |         |                 |             |     |
| 47. COMPONENT  | rs                                    | <i>!</i> **         |             |                   |        |   |      |           |        |        |         |                 |             |     |
| RECEIVER   | MU                                    | LTIPLE              | KER,        | TAP               | ET     | RANS                                    | PO   | RT &      | ELE    | CT     | RONI    | CS, TR          |             |     |
|  | 49. VO                                |                     |             |                   | -      | E POWER                                 |      | 51. STAND | BY POW | ER     | 52. PEA | K POWER         | 53. MTE     | 3F  |
| 32 LB  | TM                                    | 0.85 C              | U F         | r]                |        | WATT                                    |      |           |        |        |         |                 |             |     |
| 54. INTERFERENCE   |                                       | AGNETIC<br>RFERENCE | 56. INTE    | UCLEAR<br>RFERENC | E .    | 57. THE                                 | FERE | ŇCE       | 58. Sł | HEL    | DING    |                 |             |     |
| SENSITIVE  |                                       | <del></del>         |             | Ten               | DAT    | A RECO                                  | \\/E |           |        |        | 61 5954 | QUENCY OF       | ORSERVATI   | ON  |
| - J. CALIUNATIC  |                                       |                     |             |                   |        | METR                                    |      |           |        |        |         | Y TWO           |             |     |
| 62. TELEMETRY  | REQU                                  | IREMENTS            |             |                   | LLE    | HLIK.                                   |      |           |        |        | FACU    | : 1 <b>77</b> U | 110043      |     |
|  |                                       |                     |             |                   |        |   |      |           |        |        |         |                 |             |     |
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|  |                                       |                     | _           |                   |        |   |      |           |        |        |         |                 |             |     |
| 63. ADVANTAG   | ES AND                                | LIMITATI            | ONS         |                   |        |   |      |           |        |        |         |                 |             |     |
|  |                                       |                     |             |                   |        |   |      |           |        |        |         |                 |             | ]   |
| CA DEFEDENCE   |                                       |                     |             |                   |        |   |      |           |        |        | •       |                 |             |     |
| 64. REFERENCE  |                                       | NATA C:             |             |                   |        |   |      |           |        |        | 7.0     |                 | <del></del> |     |
| PRELIMINA  | AKY                                   | JATA SI             | itti        | FUR               | NI     | MBUS                                    | -F   | • NO      | ٧.,    | 19     | 10.     |                 |             |     |
|  |                                       | J                   |             |                   |        |   |      |           |        |        |         | ٠               |             |     |
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| ·  |                                       |                     |             |                   |        |   |      |           |        |        |         |                 |             |     |
| 65. HISTORICAL   | . REMA                                | RKS                 |             |                   |        |   |      |           |        |        |         |                 |             |     |
|  |                                       |                     |             |                   |        |   |      |           |        |        |         |                 |             |     |
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|  |                                       |                     |             |                   |        |   |      |           |        |        |         |                 |             | ľ   |
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|  |                                       |                     |             |                   |        |   |      |           |        |        |         |                 |             |     |
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|  |                                       |                     |             |                   |        |   |      |           |        |        |         |                 |             | ļ   |
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|  |                                       |                     |             |                   |        |   |      |           |        |        |         |                 |             |     |

#### TRANSPONDER TECHNOLOGY EXPERIMENTS



### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT. MD. 20771

|                      |                   |        |              | ,      |        |                   |       | _                  |                  |     |                 |
|----------------------|-------------------|--------|--------------|--------|--------|-------------------|-------|--------------------|------------------|-----|-----------------|
| 1. TITLE             |                   |        |              |        |        |                   |       | 2. /               | ACRONYN          | 3.  | EXP NO          |
| C-BAND TR            | RANSPONDER        |        |              |        |        |                   |       | C T                | RAN              | T   |                 |
| (TITLE CONT.         | )                 |        |              |        |        |                   |       | 4. R               | ESUME DAT        | E   | 5.<br>VERSION   |
|                      |                   |        |              |        |        |                   |       | 0.9                | /01/             | 72  | 2004            |
| 6. PRINCIPAL II      | NVESTIGATOR       | 7. OR  | GANIZATION   |        |        |                   | 8. T  | ELEPHO             | NE               |     |                 |
| STANLEY,             | H. R.             | NASA   | WALLOPS      | SSTA   | TIO    | N                 |       |                    |                  |     |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION   |        |        |                   | 11. 1 | TELEPHO            | NE               |     | •               |
|                      |                   |        |              |        |        |                   |       |                    |                  |     |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH IN | DEX NU | MBER   | 15. START<br>DATE | 16.   | COMPLETION<br>DATE | 17. STA          | TUS | į.              |
|                      |                   |        |              |        |        |                   |       |                    | OPEP             | AT: | IONAL           |
| 18. MONITOR          |                   | 19. AG | ENCY         |        | 20. PG | M OFFICE          | 21.   | TELEPHO            | ONE              |     | ·               |
| ROSENBERG            | , J.D.            | NASA   | HDQTRS       |        | 04/    | ECD               | 202   | 2 <del>-</del> 755 | -232             | 2   |                 |
| 22. VENDOR           |                   |        | 23. LOCATIO  | N      |        |                   |       | 24. FLIGHT<br>DATE | <sup>7</sup> 25. | LEA | D TIME          |
| VEGA PREC            | ISION LABS        |        | VIENNA.      | VA.    |        |                   |       | 01/6               | 8 NA             |     |                 |
| 26. INSTRUMEN        | T TYPE            |        |              |        |        |                   |       |                    |                  |     | 27.<br>SECURITY |
| TRANSPOND            | DER, 2 C-BAND     | ) VEG  | A MODEL      | 313    | C      |                   |       |                    |                  |     | UNC             |
| 28. APPLICATIO       | N .               |        |              |        |        | 29. SPACE         | CRAF  | T                  |                  |     |                 |
| GEOD                 |                   |        |              |        |        | GEOS 2            | 2     |                    |                  |     |                 |
| 30. PURPOSE          |                   |        |              |        |        |                   |       |                    |                  |     |                 |
|                      |                   |        |              |        |        |                   |       |                    |                  |     |                 |

PRIMARY-TO BE USED FOR RANGE RADAR CALIBRATION AND DATA RECORD-ING FOR EXPERIMENTATION TO DETERMINE THE ACCURACY OF THE RADAR SYSTEM FOR GEOMETRIC AND GRAVIMETRIC GEODESY INVESTIGATIONS. USED IN CONJUNCTION WITH THE C-BAND PASSIVE REFLECTOR EXPERIMENT.

#### 31. PRINCIPLES OF OPERATION

THIS SYSTEM CONSISTS OF A PAIR OF REDUNDANT C-BAND TRANSPONDERS (VEGA MODEL 313C). THE TRANSPONDERS ARE IDENTICAL EXCEPT FOR INTERNAL DELAY TIME, 5 MICROSEC VS 0.7 MICROSEC WHICH ALLOWS TRANSPONDER IDENTIFICATION. EACH TRANSPONDER HAS ITS OWN CAVITY MOUNTED HELICAL ANTENNA. THE INTERROGATION FREQUENCY IS 5690 MHZ AND THE TRANSMITTER FREQUENCY (DOWNLINK) IS 5765 MHZ. TRANSPONDER RECEIVES A PAIR OF PULSES 8 MICROSECONDS APART FROM A GROUND STATION. EIGHT MICROSECONDS AFTER RECEIVING THE FIRST OF THESE PULSES AN INTERNAL GATING PULSE IS GENERATED. THIS GATING PULSE IS PRESENT, THE SECOND GROUND PULSE WILL GEN-ERATE A RETURN PULSE AFTER A FIXED 0.7 OR 5 MICROSECOND DELAY (DEPENDING UPON WHICH OF THE TWO TRANSPONDERS IS IN OPERATION). RANGING IS OBTAINED AT THE GROUND VIA THE TIME REQUIRED TO MAKE THE ROUND TRIP LESS THE FIXED DELAY IN THE SPACECRAFT. SYSTEM RECEIVES POWER FROM THE TRANSPONDER BATTERY AND MUST TIME-SHARE THE AVAILABLE POWER WITH THE GRARR AND SECOR TRANS-IN ORDER TO DETERMINE ACCURATELY THE LONG-TERM EFFECTS PONDERS. OF AGING AND RADIATION UPON THE TRANSPONDER SYSTEM, DATA IS COM-PARED WITH THAT RETURNED FROM THE PASSIVE C-BAND REFLECTOR ALSO ON-BOARD.

#### 32. PHENOMENA OBSERVED

RF TRANSMISSION FROM GROUND STATIONS AT 5690 MHZ

#### 33. MEASUREMENT RANGE

RANGE GREATER THAN 4000 NM

34. PRECISION AND ACCURACY

RANGE PRECISION 0.7M, ACCURACY 2M.

| 35. SPECTRAL F           | ANCE    |                                       |           |                  | 10          | e coroto       | 41.05   |       | ITION      | 127 FM45 | CONCTANT    |
|--------------------------|---------|---------------------------------------|-----------|------------------|-------------|----------------|---------|-------|------------|----------|-------------|
|                          |         |                                       |           |                  |             | 6. SPECTR      | AL KE   | SOLU  | TION       | 37. TIME | CONSTANT    |
| SEE ITEM 38. FIELD OF VI |         |                                       |           | 39 680           | UND SWAT    | A<br>H         |         |       |            | L        |             |
| SS. FIELD OF VI          |         |                                       |           | 39. GNO          | UND SWAT    | <u> </u>       |         |       |            |          |             |
| 40. ANGULAR RESC         | LUTION  | A1 SPATIAL                            | RESO      | LUTION           |             |                |         |       |            |          |             |
| NA                       |         | NA                                    |           |                  |             | <u></u>        |         |       |            |          |             |
| 42. POINTING ACCU        | RACY    |                                       | RATE      |                  | 44. ALTIT   | UDF            |         | 45.1  | NCLINA     | TION     | -           |
| NA                       |         | NA                                    |           |                  | L           | CCENT          | RIC     |       |            |          | ETROGRAD    |
| 46. SPECIAL RE           |         | <del> </del>                          |           |                  |             |                |         | 1     |            |          |             |
| <del></del>              |         |                                       |           |                  | ·           |                |         | ····· |            |          |             |
| 47. COMPONEN             | TS      | · · · · · · · · · · · · · · · · · · · |           | -                | <del></del> |                |         |       |            |          |             |
| 2 VEGA MO                | DEL     | 313C TR                               | ANS       | PONDE            | RS          |                |         |       |            |          |             |
| 48. WEIGHT               | 49. VO  | LUME                                  |           | 50. AVE          | RAGE POWER  | 51. STAN       | DBY PO  | NER   | 52. PEA    | K POWER  | 53. MTBF    |
| 8 LB                     |         |                                       |           |                  |             |                | WATI    | S     | 500        | WATTS    |             |
| 54. INTERFERENCE         | 55. INT | IAGNETIC<br>ERFERENCE                 | 56. INTER | CLEAR<br>FERENCE | 57. THE     | RMAL<br>ERENCE | 58. 8   | SHIEL | DING       |          | <u> </u>    |
| SOURCE                   | NON     | 1 F                                   | NON       | <u>E</u>         | NONE        |                | <u></u> |       |            |          |             |
| 59. CALIBRATIO           | ON      |                                       |           |                  | ATA RECO    | VERY           |         |       |            |          | OBSERVATION |
| NONE                     |         |                                       | -m        | NA               |             |                |         |       | 120-4      | O MIN    | PER DAY     |
| 62. TELEMETRY            |         | IREMENTS                              |           |                  |             |                |         |       |            |          |             |
| SEE ITEM                 | 31      |                                       |           |                  |             |                |         |       |            |          |             |
|                          |         |                                       |           |                  |             |                |         |       |            |          |             |
| 63. ADVANTAG             | ES ANI  | D LIMITATIO                           | NS        |                  |             |                |         |       |            |          |             |
|                          |         |                                       |           |                  |             |                |         |       |            | <u></u>  |             |
|                          |         |                                       |           |                  |             |                | ,       |       |            |          |             |
| 64. REFERENCE            | S       |                                       |           |                  |             |                |         |       |            |          |             |
| 1)NASA PR                | ESS     | KIT FOR                               | GE        | OS-B.            | RELEA       | SE NO          | : 68    | 3-2H  | (, JA      | N 7.     | 68.***2     |
| PARAMETRI                | C AN    | NALYSIS                               | FOR       | FUTU             | IRE GEO     | DETIC          | SPA     | CEC   | CRAFT      | DEVE     | LOPMENT.    |
| REPORT NO                | . R-    | -4035-50                              | -2,       | COMM             | IUNICAT     | IONS           | AND     | SY S  | STEMS      | , INC    | . JAN 68    |
| ***3)PLAN                | I OF    | OPERATI                               | ONS       | FOR              | THE GE      | OS-B           | SPAC    | ECF   | RAFT.      | REPO     | RT NO. F    |
| 4035-45-2                | • CC    | DMMUNICA                              | TIDI      | NS SY            | STEMS       | INC.           | 001     | Γ, 6  | <b>57.</b> |          |             |
|                          |         |                                       |           | _                |             |                |         |       |            |          |             |
| 65. HISTORICAL           |         |                                       |           |                  |             |                |         |       |            | •        |             |
| GEOS 2 IS                | ALS     | SO KNOWN                              | 1 AS      | <u>EXPL</u>      | ORER 3      | 36             |         |       |            |          |             |
|                          |         |                                       |           |                  |             |                | ,       |       |            | i        |             |
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|                            | NATIONAL          |        | DNAUTICS AND<br>DARD SPACE F |          |          |                   | RATIO   | ON                |                |          |   |          |
|----------------------------|-------------------|--------|------------------------------|----------|----------|-------------------|---------|-------------------|----------------|----------|---|----------|
|                            |                   |        | GREENBELT,                   | MD. 2077 | 71       |                   |         |                   |                |          |   |          |
| 1. TITLE                   |                   |        |                              |          |          |                   |         | _                 |                | ONY.M    | 3. EXP NO                               | <u>2</u> |
|                            | C-BAND TRANS      | POND   | ER                           |          |          |                   |         | <del></del>       | RA             |          | 15                                      |          |
| (TITLE CONT.               | )                 |        |                              |          |          |                   |         |                   |                | 1 / 7 2  | 5.<br>VERSIO<br>2 0001                  |          |
| 6. PRINCIPAL II            | NVESTIGATOR       | 7. OR  | GANIZATION                   |          |          | 1                 | 8 TE    | ELEPHO            |                |          | 2 POOT                                  |          |
|                            |                   |        | <del></del>                  | STATI    | ON       |                   | _       | -824              |                |          | *************************************** | _        |
| JACKSON.<br>9. CO-INVESTIG |                   |        | GANIZATION                   | SIAII    | <u> </u> |                   |         | ELEPH             |                |          |   |          |
|                            |                   |        |                              |          |          |                   |         |                   |                |          |   |          |
| 12. CONTRACT<br>TYPE       | 13. CONTRACT NUME | ER     | 14. FLASH INDE               | X NUMBE  | R        | 15. START<br>DATE | 16. CC  | OMPLETION<br>DATE | 17             | . STAT   | US                                      | _        |
|                            |                   |        |                              |          |          |                   |         |                   |                |          |   | _        |
| 18. MONITOR                |                   | 19. AG | ENCY                         | 20.      | PGM      | OFFICE            | 21. T   | ELEPH             | ONE            | E        |   |          |
| DILLER. D                  | . S.              | IASA   | HDOTES                       | b۸       | /E       | S                 | 202     | <del>-</del> 755  | <del>-</del> 2 | 322      |   |          |
| 22. VENDOŔ                 |                   |        | 23. LOCATION                 |          |          |                   |         | 24 FLIGH<br>DATE  | т              | 25. L    | EAD TIME                                |          |
| VEGA PREC                  | ISION LARS        |        | <u>VIENNA. V</u>             | Α.       |          |                   |         |                   |                | <u> </u> |   |          |
| 26. INSTRUMEN              |                   |        |                              |          |          |                   |         |                   |                |          | 27.<br>SECURI                           |          |
|                            | ER. COHEREN       | C-BA   | ND                           |          |          |                   |         |                   |                |          | hvc                                     |          |
| 28. APPLICATIO             | N                 |        |                              | _        | —        | 9. SPACEO         |         | <u> </u>          |                |          |   |          |
| GEOD<br>30. PURPOSE        |                   |        |                              |          | L_       | GEOS (            | <u></u> | <del></del>       |                |          |   |          |
|                            | SUPPORT CAL       | TODA   | TION AND                     | EVALU    | Λ T      | TON O             | E G     | POLIA             | in             | C-B      | AND                                     | _        |
| PRIMARY -                  | TEMS AND LOC      | LOKA   | THECE STA                    | TIONS    | AI       | N IINE            | i ED    | FAR               | TH             | 1-r F    | NTEREC                                  | )        |
| RADAR SYS                  | SYSTEM. ***       | SEC    | UNIDARA -                    | PROVI    | U E      | TRAC              | KIN     | G CE              | VF             | RAG      | F                                       | •        |
|                            | T OF RADAR A      |        |                              |          |          |                   |         |                   |                |          | _                                       |          |
| 1 N 30 P P O P             | 1 DI KADAK A      |        | ieren ezn e                  |          | •        |                   |         |                   |                |          |   |          |
|                            |                   |        |                              |          |          |                   |         |                   |                |          |   |          |
| 31. PRINCIPLES             | OF OPERATION      |        |                              |          |          |                   |         |                   |                |          |   |          |
| COHERENT                   | TRANSPONDER       | ANTE   | NNA WILL                     | PROVI    | DE       | HEMI              | SPE     | RICA              | L              |          |   |          |
| COVERAGE                   | WITH BEAM AX      | IS-T   | OWARD CEN                    | ITER O   | F        | EARTH             | • G     | AIN               | 01             | 1 A X    | IS                                      |          |
| 5 DB NOMI                  | NAL , RIGHT-      | IAND   | CIRCULAR                     | POLAR    | I Z      | MOITAL            | . T     | HE A              | L I            | ITU      | DE                                      |          |
| CONTROL M                  | MAINTAINS BEA     | M AX   | (IS WITHIN                   | 1 + OR   | -        | 10 DE             | GRE     | ES C              | )F             | LOC      | AL                                      |          |
| VERTICAL                   | AND S/C OSCI      | LLAT   | ORY MOTIC                    | IN SHA   | LL       | . NOT             | DEG     | RADE              | : F            | ULS      | E                                       |          |
| DOPPLER S                  | SIGNAL BY MOR     | E TH   | IAN 0.05 F                   | TISEC    | •        | MAXIM             | UM      | DALI              | - Y            |          |   |          |
|                            | OF 65 MINUTE      | RAL    | DIATING TI                   | ME PE    | ĸ        | OKRII             | FU      | )K 3              | U              | 112      |   |          |
| CONT INUUL                 | JSLY.             |        |                              |          |          |                   |         |                   |                |          |   |          |
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|                            |                   |        |                              |          |          |                   |         |                   |                |          |   |          |
| 32. PHENOMEN               |                   |        |                              |          |          |                   |         |                   |                |          |   |          |
|                            | MISSION FROM      | GRAI   | IND STATIO                   | ONS AT   | . !      | 5690 M            | HZ      |                   |                |          |   | _        |
| 33. MEASUREM               | ENTRANGE          |        |                              |          |          |                   |         |                   |                |          |   | _        |
| 24 PRECICION               | AND ACCUS : ST    |        | ·                            |          |          |                   |         |                   |                |          |   |          |
| ST. FRECISION              | AND ACCURACY      |        |                              |          |          |                   |         |                   |                |          |   |          |

| 35. SPECTRAL I           | RANGE          |         |        | · · · · · · |           | 36.          | SPECTRA         | L RE   | SOLL  | TION    | 37. TIME                              | CONSTANT                               |
|--------------------------|----------------|---------|--------|-------------|-----------|--------------|-----------------|--------|-------|---------|---------------------------------------|--|
| 5690 MH2                 | (RANDT         | )       |        |             |           |              |                 |        |       |         |                                       |  |
| 38. FIELD OF V           | IEW            |         | 39.    | . GROL      | IND SWA   | \TH          |                 |        |       |         |                                       |  |
|                          |                |         |        |             |           |              |                 |        |       |         |                                       | •                                      |
| 40. ANGULAR RESC         | DLUTION 41. SE | ATIAL R | RESOLU | TION        |           |              |                 |        |       |         |                                       |  |
| NA                       |                | Α       |        |             | **        |              | <del>- 7;</del> |        |       |         |                                       | - : :: : : : : : : : : : : : : : : : : |
| 42. POINTING ACCU        |                |         | ATE    |             | 44. ALT   |              |                 |        |       | NCLINA  |                                       |  |
| NA                       | N              |         |        |             | 927       | ΚN           | (MEAN           | 1)     | _ 1 ] | 5 ()1   | GREES                                 |  |
| 46. SPECIAL RE           |                |         | CLV    | 11 T T      | II NON    | 1 - 0        | OUEDE           | NIT    | TO    | NEDE    | MOED                                  |  |
| OPERABLE<br>47. COMPONEN |                | AMEDU   | SET    | Will        | ייטויי דו | <b>y</b> – C | Unere           | TN I   | 181   | INSPE   | JINUEK                                |  |
| 47. COMPONEN             | 13             | •       |        |             |           |              |                 |        |       | · · ·   | · · · ·                               |  |
| 48. WEIGHT               | 49. VOLUME     |         | 1 5    | 50. AVER    | AGE POW   | ER           | 51. STAND       | BY POW | /ER   | 52. PEA | K POWER                               | 53. MTBF                               |
| 5 5                      | 13.            | 9       |        |             | 4         |              | 36              |        | -     |         | · · · · · · · · · · · · · · · · · · · |  |
| 54. INTERFERENCE         | 55. MAGNETIC   |         | NUCLE  |             | 57. INT   | HERM         |                 | 58. S  | HIEL  | DING    |                                       |  |
| SOURCE                   |                | -       |        |             | -         |              |                 |        |       |         |                                       |  |
| 59. CALIBRATIO           | ON             |         |        | 60. D       | ATA REC   | OV           | ERY             | •      |       | 61. FRE | QUENCY OF                             | OBSERVATION                            |
| NONE                     |                |         |        |             | NA        |              |                 |        |       |         |                                       |  |
| 62. TELEMETRY            | Y REQUIREM     | NTS     |        |             |           |              |                 |        |       |         |                                       | ,                                      |
| COMMAND-                 |                |         |        |             |           |              |                 |        |       |         |                                       |  |
| TELEMETR                 |                | ARAME   | TERS   | S AN        | D 2 M     | 100          | E INC           | ICA    | TI    | I ZNC   | INDICA                                | TIONS                                  |
| ONCE/MIN                 |                |         | ,,     |             |           |              |                 |        |       |         |                                       |  |
| 63. ADVANTAG             | ES AND LIMI    | TATIONS | ·      |             |           |              |                 |        |       |         |                                       |  |
|                          |                |         |        |             |           |              |                 |        |       |         |                                       |  |
| CA DEFERENCE             |                |         | .,     |             |           |              |                 |        |       |         |                                       |  |
| 64. REFERENCE            |                | CT CV   | 0.00   | MEN         | T DEC     | )   I        | DEMEN           | TC     | 200   | LIMEN   | IT DE                                 | V 1                                    |
| GEOS-C S                 |                | F1 EX   | אשא    | IMEN        | 1 KEG     | 10 I         | KEMEN           | 113    | DU.   | , UME   | NI 9 M.C                              | V 1,                                   |
| IZ MAT I                 | .912.          |         |        |             |           |              |                 |        |       |         |                                       |  |
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|                          |                |         |        |             |           |              |                 |        |       |         |                                       |  |
| 65. HISTORICA            | L REMARKS      |         |        |             |           |              |                 |        |       |         |                                       |  |
|                          |                |         |        |             |           |              |                 |        |       |         |                                       | -                                      |
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|                      |   |        | GREENBE   | LI, MU | . 20//1 |                   |                  |  |             |        |                 |
|----------------------|---|--------|-----------|--------|---------|-------------------|------------------|--|-------------|--------|-----------------|
| 1. TITLE             |   |        |           |        |         |                   |                  |  | RONYM       | 3. E   | XP NO           |
| DOPPLER 8            | EACON   |        |           |        |         |                   |                  | DBE  | AC.         |        |                 |
| (TITLE CONT.         | )   |        |           |        |         |                   |                  |  | ME DATE     | 5      | ERSION          |
|                      |   |        |           |        |         |                   | <u>,</u>         |  | 01/7        | [2] [3 | ) UÛ 3          |
| 6. PRINCIPAL IN      | VESTIGATOR  |        | GANIZATIO |        |         |                   | 8. TI            | ELEPHON                                      |             |        |                 |
| ANDFRLE.             | R.J.  | NAVA   | L WEAL    | PONS   | LABOR   | CATORY            |                  |  |             |        |                 |
| 9. CO-INVESTIG       | ATOR  | 10. OR | GANIZATI  | ON     |         |                   | 11. T            | ELEPHON                                      | E           |        |                 |
|                      |   |        |           |        |         |                   |                  |  |             |        |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB   | ER     | 14. FLASH | INDEX  | NUMBER  | 15. START<br>DATE | 16. <sup>C</sup> | OMPLETION 1                                  |             |        |                 |
|                      |   |        |           |        |         |                   |                  |  | PERA        | TIC    | INAL            |
| 18. MONITOR          |   | 19. AG |           |        |         | M OFFICE          |                  | ELEPHON                                      |             |        |                 |
| ROSENBERG            | , J.D.  | NASA   | HDQTI     | -      | [OA7    | 'ECD              | <u> 1505</u>     | 755-   |             |        |                 |
| 22. VENDOR           |   |        | 23. LOCA  |        |         |                   |                  | 24. FLIGHT<br>DATE                           | +           | EAD    | TIME            |
| JHU/JPL              |   |        | SILVE     | P SPR  | ING , M | 1D.               |                  | 01/68  | NΔ          |        | 1.03            |
| 26. INSTRUMEN        |   |        |           |        |         |                   |                  |  |             |        | 27.<br>SECURITY |
| BEACON, 3            | RADIO-FREQU   | JENCY  | TRAN      | SMITT  | ER      |                   |                  |  |             |        | UNC             |
| 28. APPLICATIO       | N   |        |           |        |         | 29. SPACE         |                  | <u>T                                    </u> |             |        |                 |
| GEOD                 |   |        | <u> </u>  |        |         | GFOS 2            | 2                |  |             |        |                 |
| 30. PURPOSE          | W. H. J. W. B. W. |        |           |        |         |                   |                  |  |             |        |                 |
|                      | O REFINE KNO  |        |           |        |         |                   |                  |  |             |        |                 |
|                      | IONAL FIELD. *  |        |           |        |         |                   |                  |  |             |        | 4               |
|                      | ISE POSITIONS   |        |           |        |         |                   |                  | IND ST                                       | ATIC        | NS     |                 |
| RELATIVE             | TO THE CENTE  | ER OF  | THE !     | MASS   | OF TH   | HE EART           | ГН.              |  |             |        |                 |
| Ti                   |   |        |           |        |         |                   |                  |  |             |        |                 |
|                      |   |        |           |        |         |                   |                  |  |             |        |                 |
|                      | OF OPERATION  |        |           |        |         |                   |                  |  | <del></del> |        |                 |
|                      | PLER TRANSMIT   |        |           |        |         |                   |                  | _  |             |        | - N             |
|                      | GEODETIC RES  |        |           |        |         |                   |                  |  |             |        |                 |
|                      | AND IN THE NA   |        |           |        |         |                   |                  |  |             |        |                 |
|                      | 3 RADIO-FREG  |        |           |        |         |                   |                  |  |             |        | •               |
|                      | 1HZ, 2 INTER(   |        |           |        |         |                   |                  |  |             |        |                 |
|                      | ING CIRCUI <b>t</b> ry  |        |           |        |         |                   |                  |  |             |        |                 |
|                      | OF 3 COHERENT   |        |           |        |         |                   |                  |  |             |        | _               |
|                      | DR, ALLOWS TH   |        |           |        |         |                   |                  | _  |             | ON     | -               |
|                      | REFRACTION EF   |        |           |        |         |                   |                  |  |             |        | PLER            |
| 1                    | N THE SATELL!   |        |           |        |         |                   |                  |  |             |        |                 |
| 1                    | T AT 325 MHZ  |        |           |        |         |                   |                  |  | E 16        |        |                 |
|                      | TRANSMITTERS  |        |           |        |         |                   |                  |  |             |        | ARK-            |
|                      | THE THIRD TH  |        |           |        |         |                   |                  |  |             |        |                 |
|                      | JSE THE MAIN  |        | ER SUP    | PLY C  | F THE   | SPACI             | ECRA             | AFT AN                                       | D NO        | )RMA   | ALLY            |
| TRANSMIT             | CONTINUOUSLY  | 1.     |           |        |         |                   |                  |  |             |        |                 |
|                      |   |        |           |        |         |                   |                  |  |             |        |                 |
| 1                    |   |        |           |        |         |                   |                  |  |             |        |                 |
|                      |   |        |           |        |         |                   |                  |  |             |        |                 |
| ļ                    |   |        |           |        |         |                   |                  |  |             |        |                 |
|                      |   |        |           |        |         |                   |                  |  |             |        |                 |
| 32. PHENOMEN         | A OBSERVED  |        |           |        |         |                   |                  |  |             |        |                 |
|                      |   |        |           |        |         |                   |                  |  |             |        |                 |
| 33. MEASUREM         | ENT RANGE   |        |           |        |         |                   |                  | ,  |             |        |                 |
|                      |   |        |           |        |         |                   |                  |  |             |        |                 |

|  |                                       |  | <del></del>    |                        |
|--|---------------------------------------|--|----------------|------------------------|
| 35. SPECTRAL RANGE                     | · · · · · · · · · · · · · · · · · · · | 36. SPECTRAL RE  | SOLUTION       | 37. TIME CONSTANT      |
| 162. TO 972.                           | MHZ                                   | NA .   |                | NA                     |
| 38. FIELD OF VIEW                      | 39. GROUND SWA                        | \TH  | <del></del>    |                        |
|  | <u> </u>                              |  |                |                        |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES | OLUTION                               |  |                |                        |
| NA NA                                  | - 144 41 -                            |  | T 45 10101 (D) | 47.01                  |
| A2. POINTING ACCURACY 43. POINTING RAT | ~                                     | ITUDE<br>ECCENTRIC   | 45. INCLINA    | RETROGRADE             |
| 46. SPECIAL REQUIREMENTS               | I MED                                 | ECCENTRIC  | 111311         | RETROURABLE            |
| 46. SPECIAL REQUIREMENTS               |                                       |  |                |                        |
| 47. COMPONENTS                         |                                       | The state of the s |                |                        |
|  | OSCILLATOR                            | S. AND CIR   | CUTTRY         | <u> </u>               |
| 48. WEIGHT 49. VOLUME                  |                                       | ER 51. STANDBY PO  |                |                        |
| 11 LB                                  | 10 WAT                                |  | <u> </u>       | WATTS                  |
|  | NUCLEAR 57. INT                       | HERMAL<br>ERFERENCE 58. S  | SHIELDING      |                        |
|  | NE NO                                 |  |                |                        |
| 59. CALIBRATION                        | 60. DATA REC                          | OVERY  | 61. FR         | EQUENCY OF OBSERVATION |
| NONE                                   | REALTIM                               | E TELEMETR   | Y CON          | ITINUOUS               |
| 62. TELEMETRY REQUIREMENTS             | •                                     |  |                |                        |
| SEE ITEM 31                            |                                       |  |                |                        |
| 1                                      |                                       |  |                |                        |
|  |                                       |  |                |                        |
| 63. ADVANTAGES AND LIMITATIONS         |                                       |  |                | <u> </u>               |
|  |                                       |  |                |                        |
|  |                                       |  | <del></del>    |                        |
| 64. REFERENCES                         |                                       |  |                | 4                      |
| 1)NASA PRESS KIT FOR G                 |                                       |  | •              | -                      |
| PLAN OF OPERATIONS FOR                 |                                       |  |                |                        |
| SYSTEMS, INC. REPORT N                 |                                       |  |                |                        |
| ANALYSIS FOR FUTURE GE                 |                                       |  |                |                        |
| TION AND SYSTEMS, INC                  | . REPURE N                            | U. K-4035-   | 20+2+ J        | IAN 1905.              |
| 65. HISTORICAL REMARKS                 |                                       |  |                |                        |
| ALSO FLOWN ON GEOS 1 A                 | ND NAVY SA                            | TELLITES.  | CEIS 2         | = EYDI OPER 36         |
| AESO TEOMIN DIN GEDS I A               | NO NAVI SA                            | TELETIES.  | 0003 2         | - CAPEORER 30          |
|  |                                       |  |                |                        |
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### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT MD 20771

|                      |                   | GODE   | GREENBELT, MD. 2   | 20771   |                   |                  |                    |           |        |                 |  |
|----------------------|-------------------|--------|--------------------|---------|-------------------|------------------|--------------------|-----------|--------|-----------------|--|
| 1. TITLE             |                   |        |                    |         | •                 |                  | 2. A               | CRONYM    | 3. E   | XP NO           |  |
| DOPPLER T            | RANSMITTER        |        |                    |         |                   |                  | DB                 | EAC       |        |                 |  |
| (TITLE CONT.         |                   |        |                    |         |                   |                  | 4. RI              | SUME DATE | 5      | ERSION          |  |
|                      |                   |        |                    |         |                   |                  | 0.9                | /01/      |        | 0001            |  |
| 6. PRINCIPAL IN      | IVESTIGATOR       | 7. OR  | GANIZATION         |         |                   | 8. T             | ELEPHO             | NE        |        |                 |  |
| ANDERLE.             | R.J.              | NAVA   | L WEAPONS LA       | \B      |                   |                  |                    |           |        |                 |  |
| 9. CO-INVESTIG       |                   | 10. OR | GANIZATION         |         |                   | 11. T            | 11. TELEPHONE      |           |        |                 |  |
|                      |                   |        |                    |         |                   |                  |                    |           |        |                 |  |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | MBER    | 15. START<br>DATE | 16. <sup>C</sup> | OMPLETION<br>DATE  | 17. STA   | TUS    |                 |  |
|                      |                   |        |                    |         |                   |                  |                    |           |        |                 |  |
| 18. MONITOR          |                   | 19. AG | ENCY               | 20. PG  | M OFFICE          | 21. 1            | <b>TELEPHO</b>     | NE        |        |                 |  |
| DILLER. D            | )                 | NASA   | HDQTRS             | OA/     | 'ES               | 202              | 755                | -2322     | 2      |                 |  |
| 22. VENDOR           |                   |        | 23. LOCATION       |         |                   |                  | 24. FLIGHT<br>DATE | 25. l     | .EAD   | TIME            |  |
| JHU/ API             |                   |        | SILVER SPRIM       | IGS.    | MD.               |                  |                    |           |        |                 |  |
| 26. INSTRUMEN        | Т ТҮРЕ            |        |                    |         |                   |                  |                    |           |        | 27.<br>SECURITY |  |
| BEACON . 2           | RADIO-FREQU       | IENCY  | ' TRANSMITTER      | ₹       |                   |                  |                    |           |        |                 |  |
| 28. APPLICATIO       |                   |        |                    |         | 29. SPACE         | CRAF             | Т                  |           |        | ì               |  |
| GEOD                 |                   |        |                    |         | GEOS-             | - C              |                    |           |        |                 |  |
| 30. PURPOSE          |                   |        |                    |         |                   |                  |                    |           |        |                 |  |
| PRIMARY              | - TO REFINE       | KNOW   | LEDGE OF THE       | ST      | RUCTUF            | E (              | )F TH              | E EAF     | ?TH!   | S               |  |
|                      | ONAL FIELD.       |        |                    |         |                   |                  |                    |           |        |                 |  |
|                      |                   |        |                    |         |                   |                  |                    |           |        |                 |  |
|                      |                   |        |                    |         |                   |                  |                    |           |        |                 |  |
|                      |                   |        |                    |         |                   |                  |                    |           |        |                 |  |
|                      |                   |        |                    |         |                   |                  |                    |           |        |                 |  |
| 31. PRINCIPLES       | OF OPERATION      |        |                    |         |                   |                  | ,                  |           |        |                 |  |
| Δ THREE              | EREQUENCY VE      | RSIC   | N OF THIS DO       | 1PPI    | FR TRA            | NSN              | ALTTE              | R HA      | 5      |                 |  |
|                      | •                 |        | HAS BEEN US        |         |                   |                  |                    |           |        | 1               |  |
|                      |                   |        | THE TRANSMI        |         |                   |                  |                    |           |        |                 |  |
|                      |                   |        | IT THE COMPUT      |         |                   |                  |                    |           |        |                 |  |
|                      |                   |        | CTION EFFECT       |         |                   |                  |                    |           | - אר ז | , I             |  |
|                      |                   |        | THE MAIN POWE      |         |                   |                  |                    |           |        | •               |  |
|                      |                   |        | TIT CONTINUOL      |         |                   | 101              | 1116.              | 3 FAC     | 1,     |                 |  |
| CRAIT AND            | NURMALL! I        | HNO    | TI CONTINUO        | ) J L 1 | •                 |                  |                    |           |        |                 |  |
|                      | •                 |        |                    |         |                   |                  |                    |           |        |                 |  |
|                      |                   |        |                    |         |                   |                  |                    |           |        |                 |  |
|                      |                   |        |                    |         |                   |                  |                    |           |        |                 |  |
|                      |                   |        |                    |         |                   |                  | •                  |           |        | 1               |  |
|                      |                   |        |                    |         |                   |                  |                    |           |        |                 |  |
|                      |                   |        |                    |         |                   |                  |                    |           |        |                 |  |
|                      |                   |        |                    |         |                   |                  |                    |           |        |                 |  |
|                      |                   |        |                    |         |                   |                  |                    |           |        |                 |  |
|                      |                   |        |                    |         |                   |                  |                    |           |        |                 |  |
|                      |                   |        |                    |         |                   |                  |                    |           |        |                 |  |
|                      |                   |        |                    |         |                   |                  |                    | ۰         |        |                 |  |
|                      |                   |        |                    |         |                   |                  |                    |           |        |                 |  |
| 32. PHENOMENA        | A ORCEDVED        |        |                    |         |                   | _                | <del></del>        |           |        |                 |  |
| SE. FRENUMENA        | - ODSERVED        |        |                    |         |                   |                  |                    |           |        |                 |  |
| 22 MEAGURES          | ENT DANCE         | -      |                    |         |                   |                  |                    |           |        |                 |  |
| 33. MEASUREMI        | ENI KANGE         |        |                    |         |                   |                  |                    |           |        |                 |  |
| 24 PDFOID            | AND ADDUCT TO     |        |                    |         |                   |                  |                    |           |        |                 |  |
| ST. FRECISION        | AND ACCURACY      |        |                    |         |                   |                  |                    |           |        | •               |  |

| 35. SPECTRAL RANGE                                 | 3                 | 36. SPECTRAL RE  | SOLUTION                     | 37. TIME CONSTANT  |
|--|-------------------|--|------------------------------|--|
| 162 AND 324 MHZ (TRANS                             | MIT)              | NA   |                              | NA   |
| 38. FIELD OF VIEW                                  | 39. GROUND SWA    | TH .   | X                            |  |
|  |                   |  |                              |  |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES             | DLUTION           |  |                              |  |
| NA NA  |                   |  |                              |  |
| 42. POINTING ACCURACY 43. POINTING RATI            |                   |  | 45. INCLINA                  | Contract to the contract of th |
| NA NA  | 927 K             | M(MEAN)  | 115 DEG                      | KEE S  |
| 46. SPECIAL REQUIREMENTS                           |                   |  |                              | The second secon |
| 47. COMPONENTS                                     |                   | and the second s |                              |  |
| OSCILLATOR, FREQ MULTI                             | DITED. TOW        | TRANSMITT  | FRC                          | ing and the state of the state  |
| 48. WEIGHT 49. VOLUME                              | 50. AVERAGE POW   |  | -man 1 man 1 man 1           | K POWER 53. MTBF   |
| 5 9 LB 10. CU FT                                   |                   |  | Marie T. St., may and a sub- | WATTS  |
| 54. INTERFERENCE 56. INTERFERENCE 56. INTERFERENCE |                   |  | HIELDING                     |  |
| SOURCE NONE NO                                     |                   |  |                              |  |
| 59. CALIBRATION                                    | 60. DATA REC      |  | 61. FRE                      | QUENCY OF OBSERVATION  |
| NONE   | REALTIME          | TELEMETRY  | CON                          | TINUOUS  |
| 62. TELEMETRY REQUIREMENTS                         |                   |  |                              | 7  |
| TOW PARAMETERS PER XMT                             | R ONCE PER        | MIN - FOU  | R MODE                       | INDICATION>  |
| AT LEAST ONCE PER MIN.                             |                   |  |                              |  |
|  | ; <del>- ;</del>  |  |                              | · · · · · · · · · · · · · · · · · · ·  |
| 63. ADVANTAGES AND LIMITATIONS                     |                   | · · · · · · · · · · · · · · · · · · ·  | ه د نهرسیاللا                |  |
|  |                   |  |                              |  |
| 64. REFERENCES                                     |                   |  | ,                            |  |
| GEOS-C SPACECRAFT EXPE                             | DIMENT DEC        | HITDEMENTS   | DACHMEN                      | T PEV 1  |
| 12 MAY 1972.                                       | KIMENI KEW        | OINCHENIS I  | DUCUMEN                      | I VEA TA   |
| 12 MAI 1972.                                       |                   |  |                              |  |
|  | •                 |  |                              |  |
| •  |                   |  |                              |  |
|  |                   |  |                              |  |
| 65. HISTORICAL REMARKS                             |                   |  |                              | AND THE RESERVE AND THE PARTY OF THE PARTY O |
| SIMILIAR TO GEOS-2 EXC                             | <u>EPT 2 FREQ</u> | UENCIES VS   | 3.                           |  |
|  |                   |  |                              |  |
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GREENBELT, MD. 20771

| 1. TITLE             |                   |        |                                       |        |                   |              | 2.                | ACRONYN          | 3. E     | XP NO           |  |
|----------------------|-------------------|--------|---------------------------------------|--------|-------------------|--------------|-------------------|------------------|----------|-----------------|--|
| TEN-POINT            | -SIX MICRON       | LASE   | R EXPERIMENT                          |        |                   |              | IR                | RLAS             | NA       |                 |  |
| (TITLE CONT.         | )                 |        |                                       |        |                   |              | 4. F              | RESUME DAT       | ε        | 5.<br>VERSION   |  |
|                      |                   |        |                                       |        |                   |              | 0.9               | 7/01/            |          | 0002            |  |
| 6. PRINCIPAL II      | VESTIGATOR        | 7. OR  | GANIZATION                            |        |                   | 8. TI        | ELEPHO            | NE               |          |                 |  |
| MCAVOY, N            | •                 | GODE   | ARD SPACE FL                          | T C    | ENTER             | 301-982-5042 |                   |                  |          |                 |  |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION                            |        |                   | 11. T        | ELEPHO            | ONE              |          |                 |  |
| COOPER, H            | 1. G.             | BELL   | TELEPHONE L                           | ABS    |                   | 201          | -582              | ?-300            | ^        |                 |  |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU                    | MBER   | 15. START<br>DATE | 16. C        | OMPLETION<br>DATE | 17. STA          | TUS      |                 |  |
|                      |                   |        | ·                                     |        |                   |              |                   |                  |          |                 |  |
| 18. MONITOR          |                   | 19. AG | ENCY                                  | 20. PG | M OFFICE          | 21. 7        | ELEPH             | ONE              |          |                 |  |
| BURKE, J.            | R.                | NASA   | HDQTRS                                | 0A/    | EC S              | 202          | 2-755             | 5-232            | 2        |                 |  |
| 22. VENDOR           |                   |        | 23. LOCATION                          |        |                   |              | 24. FLIGH<br>DATE | <sup>™</sup> 25. | LEAD     | TIME            |  |
| BELL TELE            | PHONE LABS        |        |                                       |        |                   |              |                   |                  | <u> </u> |                 |  |
| 26. INSTRUMEN        | T TYPE            |        |                                       |        |                   |              |                   |                  |          | 27.<br>SECURITY |  |
| TRANSPOND            | ER,10.6 MICR      | ON L   | ASER                                  |        |                   |              |                   |                  |          | 7,              |  |
| 28. APPLICATIO       | N                 |        | · · · · · · · · · · · · · · · · · · · |        | 29. SPACE         | CRAF         | T                 |                  |          |                 |  |
| COMM.                |                   |        |                                       |        | ATS-F             |              |                   |                  |          |                 |  |
| 30. PURPOSE          |                   |        |                                       |        |                   |              |                   |                  |          |                 |  |
| 00544404             | O CCTADI TCII     | TILE   | CCACIDIL TIV                          | 4410   | 1/4/1/            | - 25         |                   | 11 5 5           | D 1 1 1  |                 |  |

PRIMARY-TO ESTABLISH THE FEASIBILITY AND VALUE OF A WIDE-BAND LASER COMMUNICATION LINK BETWEEN SATELLITES BY MEASURING SUCH PARAMETERS AS S/N, BIT ERROR RATE, AND SYSTEM EFFICIENCY\*\*\*SEC-ONDARY-TO DETERMINE ATMOSPHERIC EFFECTS ON PROPAGATION AT 10.6 MICRONS.

#### 31. PRINCIPLES OF OPERATION

THE EXPERIMENT HAS TWO PHASES: LASER TRANSMISSION ALONG A HIGH DATA RATE LINK BETWEEN SATELLITE AND GROUND TERMINALS, F.G. AT GSFC, ROSMAN, AND MOJAVE DESERT, BEFORE THE LAUNCH OF ATS-G; AND RECEPTION FROM ATS-G OF SIGNALS ORIGINATING FROM A LOW-ORBITING SATELLITE AND RETRANSMITTED VIA LASER. THE LATTER SIGNALS WILL BE RETRANSMITTED AT RF BY ATS-F TO GROUND. THE LASER/OPTICS ARE USED FOR BOTH RECEIVE AND TRANSMIT. THE MAJOR OPTICAL COMPONENT IS A 5-IN CASSEGRAIN REFLECTOR; THE COLLIMATING ELEMENT IS A NEGATIVE LENS; AND THE DETECTOR IS A SENSITIVE WIDEBAND HG-CD TELLURIDE CRYSTAL OPERABLE AT TEMPERATURES UP TO 100 DEG K, THUS ALLOWING RADIATIVE COOLING. IMC IS USED TO CORRECT FOR INSTA-BILITIES IN SATELLITE POINTING. THE COMPENSATOR OPERATES BY APPLYING VARYING VOLTAGES TO PIEZOELECTRIC BIMORPHS WHICH MOVE DETECTION IS ACCOMPLISHED AFTER IMC BY HETER-ATTACHED MIRRORS. ODYING THE INCOMING SIGINAL WITH A LOCAL OSCILLATOR SIGINAL. THE RETRANSMITTED LASER SIGNAL IS MODULATED BY VARYING THE LAS-ER'S RESONANT OSCILLATOR FREQUENCY. 0.7 WATTS OF DRIVE POWER. PRODUCE 30 MHZ OF RF BANDWIDTH. OPTIONS ARE OPEN TO TRADE AMONG SIGNAL-TO-NOISE, MODULATOR POWER, BANDWIDTH, AND MODULATION IN-DEX.

#### 32. PHENOMENA OBSERVED

10.6 MICRON RADIATION FROM ATS-G

33. MEASUREMENT RANGE

| 35. SPECTRAL RANGE                           |                     | ·                                     | 36. SPECTRA  |         |             | 37. TIME C | CONSTANT    |
|--|---------------------|---------------------------------------|--|---------|-------------|------------|-------------|
| 10.6   | MIC                 | CRONS                                 | 30   | MH      | 17.         |            |             |
| 38. FIELD OF VIEW                            |                     | UND SWA                               |  |         |             |            |             |
| 0.2 BY 0.2 DEG                               |                     |                                       | EM 31  |         |             |            |             |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES       |                     |                                       |  |         |             |            |             |
| 0.2 DEG SEE IT                               |                     |                                       |  |         |             |            |             |
| 42. POINTING ACCURACY 43. POINTING RAT       | E                   | 44. ALT                               |  |         | 5. INCLINA  |            |             |
| 0.003 DEG NA                                 |                     | SYNC                                  | H CIRCUL   | -AR L   | QUATUR      | CIAL PO    | ISIGRADE    |
| 46. SPECIAL REQUIREMENTS                     | 70 FO               | 100                                   | SEC 12.  |         |             |            |             |
| S/C RADIATIVE COOLER (                       | 70 10               | 100                                   | JEG KJ   |         |             |            |             |
| 47. COMPONENTS                               | 5 <b>5 5 1</b> 5 7  | 100                                   | NETECTO  | 100     | ELECT       | TANTE S    |             |
| CO2 LASER, TELESCOPE,  48. WEIGHT 49. VOLUME |                     |                                       | ER 51. STAND   |         |             |            | 53. MTBF    |
| 23 LB 1.8 CU FT                              |                     | O WAT                                 | the same of the sa | BT FOWE | 32.11.      |            | 3 YEARS     |
|  | UCLEAR<br>ERFERENCE |                                       | HERMAL<br>ERFERENCE  | 58 SH   | IELDING     |            | 2 , 12,7,13 |
| SOURC/SEN NONE NO                            |                     |                                       | VSITIVE  |         |             | SULAT      | ION         |
| 59. CALIBRATION                              |                     | ATA REC                               |  |         |             |            | BSERVATION  |
| ACTIVE FREQUENCY CONTR                       | OLREA               | ALTIM                                 | E TELEME   | TRY     | CONT        | TINOUS     |             |
| 62. TELEMETRY REQUIREMENTS                   |                     | · · · · · · · · · · · · · · · · · · · |  |         |             |            |             |
| NONE REQUIRED; EXPERIM                       | ENT CO              | ONSIS                                 | TS OF CO   | UMMC    | VICATIO     | IN S WI    | TH 1000     |
| CHANNELS CAPACITY                            |                     |                                       |  |         |             |            |             |
| 63. ADVANTAGES AND LIMITATIONS               | <del>,</del>        |                                       |  |         |             |            |             |
|  |                     |                                       |  |         |             |            |             |
|  |                     |                                       |  |         |             |            |             |
| 64. REFERENCES                               |                     |                                       |  | •       |             | 1.00       |             |
| 1) MCAVOY, NELSON, ET A                      |                     |                                       |  |         |             |            |             |
| EXPERIMENT FOR ATS-F A                       | ND AT               | S-G, 1                                | NO. X-5  | 24-6    | 8-206.      | GSFC.      | MAY,        |
| 1968.  |                     |                                       |  |         |             |            |             |
|  |                     |                                       |  |         |             |            |             |
|  |                     |                                       |  |         |             |            |             |
| 65. HISTORICAL REMARKS                       |                     |                                       |  |         |             |            | i           |
| os. moromoza nemanio                         | •                   |                                       |  |         |             |            |             |
| <del></del>                                  |                     |                                       |  |         | <del></del> |            |             |
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|                      |                   |        | GILLENDELI, MD. 2  | 20,,,  |                   |                  |                    |            | _    |                 |  |
|----------------------|-------------------|--------|--------------------|--------|-------------------|------------------|--------------------|------------|------|-----------------|--|
| 1. TITLE             |                   |        |                    |        |                   |                  | 2. /               | ACRONYM    | 3. I | XP NO           |  |
| INTERROGA            | ITION, RECORD     | ING,   | AND LOCATIO        | N S    | YSTEM             |                  | IR                 | LS         |      |                 |  |
| (TITLE CONT.         | )                 |        |                    |        |                   |                  | 4. R               | ESUME DATE |      | 5.<br>VERSION   |  |
|                      |                   |        |                    |        |                   |                  | 0.9                | /01/7      | 2    | 0005            |  |
| 6. PRINCIPAL II      | NVESTIGATOR       | 7. OR  | GANIZATION         |        |                   | 8. TELEPHONE     |                    |            |      |                 |  |
| HOGAN, G.            | D.                | GODD   | ARD SPACE FL       | T C    | ENTER             | 301-982-5042     |                    |            |      |                 |  |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION         |        | 11. T             | ELEPHO           | NE                 | -          |      |                 |  |
|                      |                   |        |                    |        |                   |                  |                    |            |      |                 |  |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | MBER   | 15. START<br>DATE | 16. <sup>C</sup> | OMPLETION<br>DATE  | 17. STA1   | rus  |                 |  |
|                      |                   |        |                    |        |                   |                  |                    | OPERA      | ΤI   | DNAL            |  |
| 18. MONITOR          |                   | 19. AG | ENCY               | 20. PG | M OFFICE          | 21. 1            | ELEPHO             | ONE        |      |                 |  |
| SCHARDT,             | В.В.              | NASA   | HDQTPS             | OA/    | ERN               | 202              | 755                | -2322      |      |                 |  |
| 22. VENDOR           |                   |        | 23. LOCATION       |        |                   |                  | 24. FLIGHT<br>DATE | 7 25. L    | EAD  | TIME            |  |
| RADIATION            | INC               |        | MELBOURNE, F       | LOR    | IDA               |                  | 4/69               | NNA        |      |                 |  |
| 26. INSTRUMEN        | T TYPE            |        |                    |        |                   |                  |                    |            |      | 27.<br>SECURITY |  |
| TRANSPOND            | ER, UHF           |        |                    |        |                   |                  |                    |            |      | UNC             |  |
| 28. APPLICATIO       | N                 |        |                    |        | 29. SPACE         | CRAF             | T                  |            |      |                 |  |
| MET, OCEA            | N, COMM, NAV      | , B1   | OL                 |        | NIMBUS            | 3                |                    |            |      |                 |  |
| 30. PURPOSE          |                   |        |                    |        |                   |                  |                    |            |      |                 |  |
| PRIMARY-             | TO DEMONSTRA      | TE T   | HAT A SATELL       | ITE    | CAN E             | E TE             | RMIN               | E THE      |      |                 |  |

PRIMARY- TO DEMONSTRATE THAT A SATELLITE CAN DETERMINE THE POSITION OF PLATFORMS CONTAINING SENSORS, RECORD THEIR DATA, AND THEN RADIO THE RESULTS TO A GROUND STATION FOR DISSEMINATION.\*\*\* SECONDARY- TO PROVIDE METEOROLOGICAL AND OTHER DATA AS SENSED BY REMOTE SENSORS.

#### 31. PRINCIPLES OF OPERATION

THIS INSTRUMENT IS SIMILAR TO THAT FLOWN ON NIMBUS D. SISTS OF A TRANSMITTER (401.5 MHZ) WITH A VACUUM TUBE FINAL STAGE, RECEIVER (466 MHZ), DECODING AND CODING CIRCUITS, RANGE DETECTOR, AND MEMORY (20 KBIT). THE DATA MODULES, EACH WITH A UNIQUE ADDRESS, OF WHICH THE BALLOON INTERROGATION PACKAGE (BIP) IS AN EXAMPLE. CONTAIN A RECEIVER (401.5 MHZ), DECODING AND COD-ING CIRCUITS, DATA SENSORS AND A TRANSMITTER (466 MHZ). AS THE S/C PASSES WITHIN RANGE OF A COMMAND AND DATA ACQUISITION STA-TION (CDA) UP TO 20 COMMANDS CAN BE SENT AND STORED IN THE IRLS A COMMAND CONSISTS OF A TIME FOR AN INTERROGATION AND THE ADDRESS OF THE BIP (OR OTHER MODULE) TO BE CONTACTED. WHEN THE STORED COMMAND TIME AND THE S/C CLOCK TIME COINCIDE. THE S/C IRLS TRANSMITS THE ASSOCIATED BIP ADDRESS. THE BIP RESPONDS AND TRANSMITS ITS SENSOR READINGS. THESE AND THE ROUND TRIP SIGNAL DELAY TIME BETWEEN THE BIP AND THE S/C ARE STORED IN THE IRLS MEMORY. THIS PROCEDURE IS REPEATED FOR EACH STORED COMMAND UNTIL THE CDA INITIATES TRANSMISSION OF THE MEMORY CONTENTS AND THE STORAGE OF NEW COMMANDS IN THE MEMORY. KNOWING THE S/C PO-SITIONS AND TWO RANGES TAKEN ABOUT 150 SEC APART, THE POSITION OF A MODULE CAN BE FOUND TO WITHIN 2 KM.

#### 32. PHENOMENA OBSERVED

TRANSMISSIONS OF DATA FROM REPORTING PLATFORMS

#### 33. MEASUREMENT RANGE

#### 34. PRECISION AND ACCURACY

PLATFORM LOCATION TO +-0.6 NM; DELAY TIME TO 0.625 MICROSECOND

| 35. SPECTRAL RANGE   |                      |           | 36. SPECTR          | AL RE                                  | SOLUTION    | 37. TIME    | CONSTANT     |
|--|----------------------|-----------|---------------------|--|-------------|-------------|--------------|
| 466. AND 401.5   | MH                   | 7         |                     |  |             | 1           |              |
| 38. FIELD OF VIEW  |                      | UND SWA   | TH                  |  |             |             |              |
|  |                      |           |                     |  |             |             |              |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES   | OLUTION              |           |                     |  |             |             |              |
| To DOUBLE OF THE POST OF THE P | _                    | 44 ALTI   | TUBE                |  | 45. INCLIN  | IATION      |              |
| 42. POINTING ACCURACY 43. POINTING RAT   | E                    | 44. ALTI  | CIRCUL              | A D                                    | SUN-S       |             | RETROGRADE   |
| 46. SPECIAL REQUIREMENTS   |                      | MED       | CINCOL              | Ath                                    | 3011 3      | 171017      | CE TICOUNTUE |
| REACTS ONLY TO PREVIOU   | S GRO                | JND CO    | DMMAND              | FOR                                    | SENSO       | RINTER      | ROGATION     |
| 47. COMPONENTS   |                      |           |                     | ···········                            | ··. y       | 7           |              |
| RECEIVER, TRANSMITTER,   | ELEC                 | <u> </u>  | CS.                 |  |             |             |              |
| 48. WEIGHT 49. VOLUME  | - w was a comment    | v         | R 51. STAN          | OBY POV                                | <del></del> |             |              |
| 26 LB 0.4 CU F   |                      | B WAT     | FERMAL<br>REFERENCE | T = 0 =                                | HIELDING    | 7 WATTS     | <u>SI</u>    |
|  | YUCLEAR<br>ERFERENCE |           | NSITIVE             |  | HIELDING    | <del></del> |              |
| SOURC/SEN  | 60. D                | ATA REC   |                     | ــــــــــــــــــــــــــــــــــــــ | 61. FF      | REQUENCY OF | OBSERVATION  |
|  |                      |           | TELEME              | TRY                                    | ON          | COMMAN      | ND           |
| 62. TELEMETRY REQUIREMENTS   |                      |           |                     |  |             |             |              |
| 20 CHANNELS: 5 DIGITAL   | AND                  | LS ANA    | ALDG, S             | AMP                                    | LED BE      | TWEEN 1     | L AND 16     |
| SECONDS: 12.5 KBITS PE   | R SECI               | OND.      |                     |  |             |             |              |
|  |                      |           |                     |  |             |             |              |
| 63. ADVANTAGES AND LIMITATIONS   | 10.01                | . T.C.O.L | 4.0                 |  | <del></del> |             |              |
| LIMITED AT PRESENT TO  | 12 PL                | ATEURN    | 15                  |  |             |             |              |
| 64. REFERENCES   |                      |           | ·                   | · ·                                    |             | a company   |              |
| 1) NORMYLE, W.J.: NIMB   |                      |           |                     |  |             |             |              |
| AVAIATION WEEK AND SPA   |                      |           |                     |  |             |             |              |
| 2) PRESS KIT NIMBUS B. NIMBUS B. COMMAND AND T   |                      |           |                     |  |             |             |              |
| SUBSYSTEMS, GENERAL EL   |                      |           |                     |  |             |             | 1            |
| SOBSTSTERS OF OUNCE, CE  |                      |           | , , , , , , , ,     |  |             |             |              |
| 65. HISTORICAL REMARKS   |                      |           |                     |  | ···         |             |              |
| SIMILAR TO NIMBUS D IR   | LS                   |           |                     |  |             | · -         |              |
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| GREENBELT, MD. 20771 |                   |        |                 |         |                   |         |                        |                 |  |
|----------------------|-------------------|--------|-----------------|---------|-------------------|---------|------------------------|-----------------|--|
| 1. TITLE             |                   |        |                 |         |                   |         | 2. ACRONYM             | 3. EXP NO       |  |
| INTERROGA            | ATION, RECORD     | ING    | AND LOCA        | TION SY | STEMS             | 5       | IRLS                   |                 |  |
| (TITLE CONT.         |                   | _      | -               |         |                   |         | 4 RESUME DATE          | 5.<br>VERSION   |  |
|                      |                   | 7      |                 | ****    | _                 |         | 09/01/7                |                 |  |
| 6. PRINCIPAL IN      | VESTIGATOR        | 7. OR  | GANIZATION      |         |                   | 8. TEL  | EPHONE                 |                 |  |
| HOGAN, G.            | D.                | GODE   | DARD SPACE      | FLT CE  | NTER              | 301-    | -982-5042              |                 |  |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION      |         |                   | 11. TE  | LEPHONE                |                 |  |
| NONE                 |                   |        |                 |         |                   |         |                        |                 |  |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX | NUMBER  | 15. START<br>DATE | 16. COM | PLETION 17. STAT       | US              |  |
|                      |                   |        |                 |         |                   |         | OPERA                  | TIONAL          |  |
| 18. MONITOR          |                   | 19. AG | ENCY            | 20. PGM | OFFICE            | 21. TE  | LEPHONE                |                 |  |
| SCHARDT,             | B • B •           | NASA   | 4 HDQTRS        | OA/E    | RN                | 202-    | -755 <del>-</del> 2322 |                 |  |
| 22. VENDOR           | -                 |        | 23. LOCATION    |         |                   |         | 24. FLIGHT 25. L       | EAD TIME        |  |
| RADIATION            | N. INC.           | Ą      | FLBOURNE,       | FLORIC  | Α                 |         | 04/70 NA               |                 |  |
| 26. INSTRUMEN        | Т ТҮРЕ            |        |                 |         |                   |         |                        | 27.<br>SECURITY |  |
| TRANSPONE            | DER, UHF          |        |                 |         |                   |         |                        | UNC             |  |
| 28. APPLICATIO       |                   |        |                 | 2       | 9. SPACE          | CRAFT   |                        |                 |  |
| MET, COM             | ۸.                |        |                 | ١       | IIMBUS            | 5-4     |                        |                 |  |
| 30. PURPOSE          |                   |        |                 |         |                   |         |                        |                 |  |
| PRIMARY-             | TO LOCATE SU      | JCCES  | SSIVE POSI      | TIONS C | F EAC             | H UI    | VIT OF A               | SET OF          |  |
| IN-SITU              | DATA-GATHERIN     | IG MO  | DOULES (E.      | G., THE | BALL              | .00N    | INTERRO                | NOITA           |  |
| PACK AGE (           | BIP)); TO REC     | EIVE   | E AND STORI     | E IN TH | IE S/C            | THE     | E DATA ME              | ASURED          |  |
| BY EACH              | MODULE; TO TR     | RANS   | MIT THE ST      | ORED DA | TA TO             | ) A (   | GROUND ST              | ATION           |  |
| FOR PROCE            | ESSING. THE       | 0838   | ECTIVE IS       | TO ESTA | BLISH             | 1 A 1   | HORLD-WID              | E NET           |  |
| FOR OBTA             | INING WIND AN     |        |                 |         |                   |         |                        |                 |  |
|                      | OF OPERATION      |        |                 |         |                   |         |                        |                 |  |
| THIS INST            | TRUMENT IS SI     | MILA   | AR TO THAT      | FLOWN   | ON NI             | MB U    | S 3. IT C              | ON-             |  |
| SISTS OF             | A TRANSMITTE      | ER (4  | 401.5 MHZ)      | WITH A  | SOLI              | D S     | TATE FINA              | ונ              |  |
| STAGE, PE            | ECEIVER (466      | MHZ    | ) DECODING      | G AND C | CODING            | CIF     | RCUITS, F              | RANGE           |  |
| DETECTOR             | AND MEMORY        | 100    | KBIT). TI       | HE DATA | MODU              | JLES    | EACH WIT               | гна             |  |
| UNIQUE A             | DDRESS, OF WI     | HICH   |                 |         |                   |         |                        |                 |  |
|                      | AMPLE, CONTAI     |        |                 |         |                   |         |                        | ID COD-         |  |
|                      | JITS, DATA SE     |        |                 |         | _                 |         |                        | S THE           |  |
| L                    | ES WITHIN RAN     |        |                 |         | _                 |         | JISITION               |                 |  |
| TION (CD             |                   |        | MANDS CAN       |         | AND               |         |                        |                 |  |
| MEMORY.              | A COMMAND CO      |        |                 |         |                   |         |                        |                 |  |
|                      |                   |        |                 |         |                   |         |                        |                 |  |
|                      | ESS OF THE BI     |        |                 |         |                   |         |                        |                 |  |
|                      | ED COMMAND TI     |        |                 |         |                   |         |                        |                 |  |
|                      | NSMITS THE AS     |        |                 |         |                   |         |                        |                 |  |
|                      | S ITS SENSOR      |        |                 |         |                   |         |                        |                 |  |
| 1                    | ME BETWEEN TH     |        |                 |         |                   |         |                        |                 |  |
| MEMORY.              | THIS PROCEDU      |        |                 |         |                   |         |                        |                 |  |
|                      | E CDA INITIAT     |        |                 |         |                   |         |                        |                 |  |
|                      | AGE OF NEW CO     |        |                 |         |                   |         |                        |                 |  |
|                      | AND TWO RANGE     |        |                 |         | C APA             | ART,    | THE POST               | TION            |  |
| OF A MODE            | JLE CAN BE FO     | DUND   | TO WITHIN       | 2 KM.   |                   |         |                        |                 |  |
| 32. PHENOMEN         |                   |        |                 |         |                   |         |                        |                 |  |
|                      | SIONS FROM RI     | MOT    | E PLATFORM      | S-BALL  | DONS,             | BUO     | YS, SURFA              | CE PKG          |  |
| 33. MEASUREM         | ENT RANGE         |        |                 |         |                   |         |                        |                 |  |
|                      |                   |        |                 |         |                   |         |                        |                 |  |
|                      | AND ACCURACY      |        |                 |         |                   |         |                        |                 |  |
| LOCATION             | TO +-1.1 NM       | DE     | LAY TIME TO     | 0.629   | MICE              | ROSEC   | ·                      |                 |  |

|   |                                       |                       |        |                 | [                   |              |                      | T         |   |
|---|---------------------------------------|-----------------------|--------|-----------------|---------------------|--------------|----------------------|-----------|---|
| 35. SPECTRAL RANGE                      | 10 /01                                |                       | MILT   |                 | 36. SPECTRA         | AL RESO      |                      | 1         | CONSTANT  |
| 466. AN                                 | ID 401                                |                       | MHZ    |                 | NA                  |              | <b>3</b>             | NA        |   |
| 38. FIELD OF VIEW                       | · · · · · · · · · · · · · · · · · · · |                       |        | ND SWA          | TH                  |              |                      |           |   |
| NA                                      |                                       |                       | I A    |                 |                     |              |                      |           |   |
| 40. ANGULAR RESOLUTION                  | 41. SPATIAI                           | L RESOLU              | JTION  |                 |                     |              |                      |           |   |
|   |                                       |                       |        |                 |                     |              |                      |           |   |
| 42. POINTING ACCURACY 43                | . POINTING                            | RATE                  |        | 14. ALTI<br>MED | CIRCUL              | - · · · · I  | 5. INCLINA<br>SUN-SY |           | ETROGRADE   |
| 40 000000000000000000000000000000000000 |                                       |                       |        | MED             | CIRCUL              | AR ,         | 3014-31              | WCH P     | LINGGRADE   |
| 46. SPECIAL REQUIREM                    | ENIS                                  |                       |        |                 |                     |              |                      |           |   |
|   |                                       |                       |        |                 |                     | -            |                      |           | <del></del>   |
| RECEIVER, TRA                           | NCMTTT                                | E0 E                  | TETT   | DINIT           | C. MEM              | nev.         | ANTEN                | NIA .     | , and a great and |
| <del></del>                             |                                       |                       |        |                 |                     |              | _                    |           | 53. MTBF  |
| 48. WEIGHT 49. VOL                      |                                       | U FT                  |        | WAT             | R 51. STAND         | BA POWER     |                      | WATTS     |   |
|   |                                       |                       |        |                 | HERMAL<br>REFERENCE | 50 0111      |                      | WAITS     | <u> </u>  |
| 54. INTERFERENCE 55. INTER              | FERENCE                               | 56. NUCLE<br>INTERFER | RENCE  | 57. INTE        | RFERENCE            | 58. SHI      | ELDING               |           |   |
| SOURC/SEN                               |                                       | <u> </u>              | lee Da | TA 550          | - OVERV             | l            | [c1 505              | OUENCY OF | DBSERVATION   |
| 59. CALIBRATION                         |                                       |                       |        |                 | OVERY<br>TELEME     | TDV          |                      | COMMAN    |   |
| CO TELEMETRY DECISION                   | DEMENTS                               | <u></u>               | UEL    | ATEU            | IELEME              | 157          | אטן                  | COMMAN    | (1.)  |
| 20 CHANNELS:                            |                                       | T A 1 .               | NO 1   | E ANI           | AL OC C             | AMOLI        | D DET                | WEEN 1    | AND 14  |
|   | 5 0161                                | IAL A                 | MD I   | D AN            | ALUG, S             | AMPLE        | יםם עבי              | MCEN I    | AND TO  |
| SECONDS                                 |                                       |                       |        |                 |                     |              |                      |           |   |
| C2 ADVANTACES AND                       | LIMITATIO                             | NC                    |        | <del></del>     | -                   |              |                      |           |   |
| 63. ADVANTAGES AND                      |                                       | -                     | NC C   | OL AD           | - DOMED             | COLLO        | - TC                 | 10 001    | NOC +   |
| TOTAL BIP WEI                           |                                       |                       |        |                 |                     |              |                      |           |   |
| BIPS NEAR THE                           | EQUAT                                 | JK MA                 | YNU    | IKE             | SPUND U             | <u>N 200</u> | 7CE221               | VE UKB    | 113   |
| 64. REFERENCES                          | *0.0                                  | CHOCK                 | CTCH   | 010             | CTOOK               | 10051        | T 14 1               | CENEDA    | 4   |
| 1) JONES, H.,                           |                                       |                       |        |                 |                     |              |                      |           |   |
| ELECTRIC CO.,                           |                                       |                       |        |                 |                     |              |                      |           |   |
| INTERIM REPOR                           |                                       |                       |        |                 |                     | CAL          | LAZIKO               | MENI 2    | NASA/EKL  |
| REPORT NO. PM                           | 1-6/13,                               | JUNE                  | 8,     | 1967            | •                   |              |                      |           | ·   |
|   |                                       |                       |        |                 | •                   |              |                      |           |   |
| OF HUSTORICAL DEMAN                     |                                       |                       |        |                 |                     |              |                      |           |   |
| 65. HISTORICAL REMAR                    |                                       |                       | TD: C  |                 |                     |              |                      |           |   |
| SIMILAR TO TH                           | IE NIMB                               | 05 3                  | IKE 2  |                 |                     |              |                      |           |   |
|   |                                       |                       |        |                 |                     |              |                      |           |   |
|   |                                       |                       |        |                 |                     |              |                      |           |   |
|   |                                       |                       |        |                 |                     |              |                      |           |   |
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|   |                                       |                       |        |                 |                     |              |                      |           |   |
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|   |                                       |                       |        |                 |                     |              |                      |           | 4   |
|   |                                       |                       |        |                 |                     |              | ,                    |           |   |
|   |                                       | •                     |        |                 |                     |              |                      |           |   |
| [                                       |                                       |                       |        |                 |                     |              |                      |           |   |
|   |                                       |                       |        |                 |                     |              |                      |           | •   |
|   |                                       |                       |        |                 |                     |              |                      |           |   |
|   |                                       |                       |        |                 | •                   |              |                      |           |   |
|   |                                       |                       |        |                 |                     |              |                      |           |   |
| 1                                       |                                       |                       |        |                 |                     |              |                      |           |   |
|   |                                       |                       |        |                 |                     |              |                      |           |   |
|   |                                       |                       |        |                 |                     |              |                      |           | 1   |
|   |                                       |                       |        |                 |                     |              |                      |           |   |

|                      |                    |             | GREE   | NBELT, | , MD.                                  | 20771  |                                       |       |                  |                  |        |               |                 |
|----------------------|--------------------|-------------|--------|--------|--|--------|---------------------------------------|-------|------------------|------------------|--------|---------------|-----------------|
| 1. TITLE             |                    |             |        |        |  |        |                                       |       | 2                | . ACR            | ONYM   | 3. E          | XP NO           |
| MICROWAVE            | <b>TRANSPONDER</b> | ₹           |        |        |  |        |                                       |       | M                | TPA              | N      |               |                 |
| (TITLE CONT.         | )                  |             |        |        |  |        |                                       |       | 4                | . RESUM          | E DATE |               | 5.<br>VERSION   |
|                      |                    |             |        |        |  |        |                                       |       | 0                | 9/0              | 1177   |               | 2004            |
| 6. PRINCIPAL II      | NVESTIGATOR        | 7. OR       | GANIZA | ATION  |  |        |                                       | 8. T  | ELEPH            | ONE              |        |               |                 |
| DARCEY. F            | ₹.J.               | GOD         | )ARD   | SPA(   | OF F                                   | LTC    | ENTER                                 | 301   | -98              | 2-5              | C41    |               |                 |
| 9. CO-INVESTIG       | ATOR               | 10. OR      | GANIZ  | ATION  |  |        |                                       | 11. T | ELEPH            | IONE             |        |               |                 |
|                      |                    |             |        |        |  |        |                                       |       |                  |                  |        |               |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB  | BER         | 14. FL | ASH IN | DEX NU                                 | JMBER  | 15. START<br>DATE                     | 16. C | OMPLETIC<br>DATE | <sup>™</sup> 17. | STAT   | ับร           |                 |
|                      |                    |             |        |        | -                                      |        |                                       | 12    | 2/66             | OF               | PERA   | TI            | ONAL            |
| 18. MONITOR          |                    | 19. AG      | ENCY   |        |  | 20. PG | M OFFICE                              | 21. 1 | ELEP             | HONE             |        |               |                 |
| BURKE, J.            | . R .              | NAS         | HD!    | QTRS   |  | DA/    | ECS                                   | 202   | 2-75             | 5-2              | 2322   |               |                 |
| 22. VENDOR           |                    |             | 23. LC | CATIO  | N                                      |        |                                       |       | 24. FLIC<br>DAT  | HT<br>E          | 25. L  | EAD           | TIME            |
| HUGHES A             | IRCRAFT CO         |             | EL     | SEGUN  | 100,                                   | CAL    | IFORN                                 | IA 1  | 2/6              | _                | NA     |               |                 |
| 26. INSTRUMEN        | IT TYPE            |             |        |        |  |        | · · · · · · · · · · · · · · · · · · · |       |                  |                  |        |               | 27.<br>SECURITY |
| TRANSPONE            | DER, 6-GHZ (F      | RECE        | (JE)   | 4-G)   | 1Z (                                   | TRAN   | SMIT)                                 | SHF   | -                |                  |        |               | TUNC            |
| 28. APPLICATIO       | N                  | <del></del> |        | -      |  |        | 29. SPACE                             | CRAF  | T                |                  |        |               |                 |
| COMM                 |                    |             |        |        |  |        | ATS 1                                 |       |                  |                  |        |               |                 |
| 30. PURPOSE          |                    |             |        |        |  |        |                                       |       |                  |                  |        |               |                 |
| PRIMARY-             | TO INVESTIGA       | ATE .       | THE    | TRANS  | SMIS                                   | SION   | OF V                                  | OICE  | F , T            | ELE              | VIS    | 10            | N,              |
| AND DIGIT            | TAL DATA USIN      | VG S        | SB TI  | RANS   | TTIN                                   | ER A   | ND RE                                 | CEIV  | <b>VER</b>       | IN               | MUL    | TI            | PLE             |
| ACCESS MO            | DDE AND A HIG      | GH QL       | JALI   | TY F   | Y SY                                   | STEM   | FOR                                   | TELE  | EVIS             | 101              | V AN   | ID.           | HIGH            |
| SPEED DAT            | TA RELAY.***       | SECO        | NDAR   | Y- T(  | SH C                                   | ARE    | <b>EFFIC</b>                          | IEN'  | TLY              | THE              | E SF   | PAC           | E <del>-</del>  |
| CRAFT TRA            | ANSMITTED SIG      | GNAL        | IND    | EPEN   | DENT                                   | OF     | THE N                                 | UMB ( | ER C             | F (              | CHAN   | INE           | LS              |
| IN USE.              |                    |             |        |        |  |        |                                       |       |                  |                  |        |               |                 |
| 31. PRINCIPLES       | OF OPERATION       |             |        |        |  |        |                                       |       |                  |                  |        |               |                 |
| THIS INS             | TRUMENT IS I       | DENT        | ICAL   | TU     | THAT                                   | USE    | D ON                                  | ATS-  | -2 A             | ND               | ATS    | <del>-3</del> | •               |
| RECEIVING            | G AND TRANSM       | ITTI        | NG A   | NTENI  | VAS                                    | DNA    | TRAVE                                 | LING  | 3-WA             | VE-              | -TUE   | 8 E           |                 |
| POWER AMI            | PLIFIERS ARE       | USE         | NI C   | CON    | JUNC                                   | TION   | WITH                                  | Α [   | DUAL             | _ M(             | DDE    | CO            | MM-             |
| UNICATIO             | N TRANSPONDER      | R TO        | PRO    | VIDE   | A S                                    | YSTE   | M ELE                                 | MEN.  | T CA             | PAE              | 3LE    | OF            | AC-             |
| CEPTING              | AND HANDLING       | ANY         | TYP    | E OF   | COM                                    | MUN I  | CATIO                                 | NS    | TRAF             | FI(              | D P    | ) W           | IDE-            |
| BAND COM             | MUNICATIONS.       | THE         | FRE    | QUENC  | CY T                                   | RANS   | OITAJ                                 | N M   | DDE              | IS               | DES    | IG            | NED             |
|                      | Y FOR TELEVIS      |             |        |        |  |        |                                       |       | IN               | WH]              | [CH    | ON            | E               |
|                      | RANSMITTER U       | -           |        |        |  |        |                                       |       | • Th             | IE (             | JSAE   | LE            |                 |
|                      | H IS 25 MHZ.       |             |        |        |  |        |                                       |       |                  |                  |        | -             |                 |
|                      | HE INTERCONNI      |             |        |        |  |        |                                       |       |                  |                  |        |               |                 |
| li e                 | H CHANNEL CAI      |             |        |        |  |        |                                       |       |                  |                  |        |               |                 |
| -                    | Y DIVISION M       |             |        |        |  |        |                                       |       |                  |                  |        |               |                 |
|                      | FOR THE VARIO      |             |        |        |  |        |                                       |       |                  |                  |        |               |                 |
|                      | CONVERTED I        |             |        |        |  |        |                                       |       |                  |                  |        |               |                 |
| li .                 | ECRAFT AND A       |             |        |        |  |        |                                       |       |                  |                  |        |               |                 |
|                      | CH GROUND STA      |             |        |        |  |        |                                       |       |                  |                  |        |               |                 |
|                      | VERED BASEBA       |             |        |        |  |        |                                       |       |                  |                  |        |               |                 |
| 1                    | INTERCONNECT       |             |        |        |  |        |                                       |       |                  |                  |        |               |                 |
| DESPUN P             | HASED ARRAY.       | THE         | EFF    | ECTI'  | VE R                                   | ADIA   | TED P                                 | OWE   | ₹ IS             | 16               | 66 k   | TAN           | TS.             |
|                      |                    |             |        |        |  |        |                                       |       |                  |                  |        |               |                 |
| 32. PHENOMEN         |                    |             |        |        |  |        |                                       |       |                  |                  |        |               |                 |
|                      | SIONS FROM A       | TS G        | ROUN   | D ST   | OITA                                   | NS A   | T 6 G                                 | HZ    |                  |                  |        |               |                 |
| 33. MEASUREM         | ENT RANGE          |             |        | ·      | ······································ |        |                                       |       |                  |                  | ·      |               |                 |
|                      |                    |             |        |        |  |        |                                       |       |                  |                  |        |               |                 |
| 34. PRECISION        | AND ACCURACY       |             |        | _      |  |        |                                       |       |                  |                  |        |               |                 |

| 35. SPECTRAL RANGE   |                    |                                       |  |                                       |                   |        |        |                |         |              |
|--|--------------------|---------------------------------------|--|---------------------------------------|-------------------|--------|--------|----------------|---------|--------------|
| . ( 13 TM / 2 <b>7</b>   |                    |                                       |  | PECTRA                                |                   |        | TION   | 37. TIME       | CONST   | ANT          |
|  | 1 GH.              | L                                     |  | 25.                                   | М                 | HZ     |        | <u> </u>       |         |              |
|  |                    | UND SWA                               |  |                                       |                   |        |        |                |         |              |
| 18.0 BY 23.0 DEG   | LIMB               | -TO-L                                 | IMB                                    | 9100                                  | ) NM              | F      | ≀ DM   | GE <u>O-S'</u> | YNCH    | ALT          |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION  | LUTION             |                                       |  |                                       |                   |        |        |                |         |              |
|  |                    |                                       |  |                                       |                   |        |        |                |         |              |
| 42. POINTING ACCURACY 43. POINTING RATE  |                    | 44. ALTI                              | TUDE                                   |                                       | 1                 | 45. IN | ICLINA | TION           |         | <u> </u>     |
|  |                    | SYNC                                  | H C                                    | IRCUL                                 | AR                | EQI    | JATO   | RIAL           | 2051    | GRADE        |
| 46. SPECIAL REQUIREMENTS   |                    |                                       | ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, |                                       | ·                 |        |        |                |         | <del></del>  |
|  |                    | •                                     |  |                                       |                   |        |        |                |         |              |
| 47. COMPONENTS   |                    |                                       |  |                                       |                   |        |        |                |         | <del> </del> |
| TRANSPONDER, ANTENNA   | 3.44               |                                       |  |                                       |                   |        |        | ,              |         |              |
| 48. WEIGHT 49. VOLUME  | 50. AVE            | RAGE POWE                             | R 51                                   | . STANDB                              | Y POWE            | R 5    | 2. PEA | K POWER        | 53. M   | TBF          |
| Market Committee |                    |                                       |  | · · · · · · · · · · · · · · · · · · · |                   | +      |        |                | -       |              |
| 54 INTERFERENCE 55 MAGNETIC 56 NU  | CLEAR<br>REFERENCE | 57                                    | HERMAL<br>REERENC                      |                                       | 58. SH            | 41E1 I | ING    |                | 1       |              |
| SOURC/SEN  | TENENCE            |                                       |  | TIVE                                  | <del>50. 01</del> |        | 71110  |                |         |              |
| 59. CALIBRATION  | 60 D               | ATA REC                               |  |                                       |                   |        | 61 FRE | QUENCY OF      | ORSERVA | ATION        |
| NA .   |                    | ALTIM                                 |  |                                       | TPV               | , +    |        | TINUOL         |         |              |
| 62. TELEMETRY REQUIREMENTS   | I K E              |                                       | L. 11                                  | LLLME                                 | 11/1              |        | CUN    | TINOUT         | در      | <del> </del> |
| NA NA  |                    |                                       | <u></u>                                |                                       |                   |        |        |                |         |              |
| 140  |                    |                                       |  |                                       |                   |        |        |                |         |              |
|  |                    |                                       |  |                                       |                   |        |        |                |         |              |
| CO ADVANTAGES AND LIGHT - TOTAL  |                    |                                       | ,                                      |                                       |                   |        |        |                |         |              |
| 63. ADVANTAGES AND LIMITATIONS   |                    |                                       |  |                                       |                   |        |        |                |         |              |
|  |                    |                                       |  |                                       |                   |        |        |                |         |              |
|  |                    |                                       |  |                                       |                   |        |        |                |         |              |
| 64. REFERENCES   |                    |                                       |  |                                       |                   |        |        | ****           |         |              |
| 1) PROJECT DEVELOPMENT   | PLAN-              | -ATS,                                 | GSI                                    | FC, G                                 | REE               | NBE    | LT,    | MD. D          | DEC.    | 1965.        |
| ***2) NASA PRESS KIT, A  | TS-B               | RELE                                  | EASE                                   | E NO.                                 | 66-               | 308    | 3 , D  | EC. 19         | 166.4   | **           |
|  |                    |                                       |  |                                       |                   |        |        |                |         |              |
|  |                    |                                       |  |                                       |                   |        |        |                |         |              |
|  |                    |                                       |  |                                       |                   |        |        |                |         |              |
| ī  |                    |                                       |  |                                       |                   |        |        |                |         |              |
|  |                    |                                       |  |                                       |                   |        |        |                |         |              |
| 65. HISTORICAL REMARKS   |                    | · · · · · · · · · · · · · · · · · · · |  |                                       |                   |        |        |                |         |              |
|  |                    | AL TO                                 | THA                                    | AT US                                 | ED                |        | ATS    | 2 AND          | ΑΤς     | . 3.         |
| 65. HISTORICAL REMARKS THIS INSTRUMENT IS INDE   | ENTIC A            | AL TO                                 | THA                                    | AT US                                 | ED                |        | ATS    | 2 AND          | ) ATS   | 3.           |
|  | ENTIC!             | L TO                                  | TH                                     | AT US                                 | ED                |        | ATS    | 2 AND          | ) ATS   | 5 3.         |
|  | ENTIC A            | AL TO                                 | THA                                    | AT US                                 | ED                |        | ATS    | 2 AND          | ) ATS   | 3            |
|  | ENTICA             | AL TO                                 | THA                                    | AT US                                 | ED                |        | ATS    | 2 AND          | ) ATS   | 5 3.         |
|  | ENTICA             | AL TO                                 | THA                                    | AT US                                 | ED                |        | ATS    | 2 AND          | ) ATS   | 3.           |
|  | ENTICA             | L TO                                  | TH                                     | AT US                                 | ED                |        | ATS    | 2 AND          | ) ATS   | 3.           |
|  | ENTICA             | L TO                                  | THA                                    | AT US                                 | ED                |        | ATS    | 2 AND          | ) ATS   | 5 3.         |
|  | ENTIC A            | AL TO                                 | THA                                    | AT US                                 | ED                |        | ATS    | 2 AND          | O ATS   | 3.           |
|  | ENTICA             | AL TO                                 | THA                                    | AT US                                 | ED                |        | ATS    | 2 AND          | ) ATS   | 3.           |
|  | ENTICA             | AL TO                                 | THA                                    | AT US                                 | ED                |        | ATS    | 2 AND          | ) ATS   | 3.           |
|  | ENTICA             | AL TO                                 | THA                                    | AT US                                 | ED                |        | ATS    | 2 AND          | ) ATS   | 3.           |
|  | ENTICA             | AL TO                                 | TH                                     | AT US                                 | ED                |        | ATS    | 2 AND          | ) ATS   | 5 3.         |
|  | ENTICA             | AL TO                                 | THA                                    | AT US                                 | ED                |        | ATS    | 2 AND          | ) ATS   | 5 3.         |
|  | ENTICA             | AL TO                                 | TH                                     | AT US                                 | ED                |        | ATS    | 2 AND          | ) ATS   | 3.           |
|  | ENTICA             | AL TO                                 | THE                                    | AT US                                 | ED                |        | ATS    | 2 AND          | ) ATS   | 3.           |
|  | ENTICA             | AL TO                                 | THE                                    | AT US                                 | ED                |        | ATS    | 2 AND          | ) ATS   | 3.           |
|  | ENTICA             | AL TO                                 | THE                                    | AT US                                 | ED                |        | ATS    | 2 AND          | ) ATS   | 3.           |
|  | ENTICA             | AL TO                                 | THA                                    | AT US                                 | ED                |        | ATS    | 2 AND          | ) ATS   | 3.           |
|  | ENTICA             | AL TO                                 | THA                                    | AT US                                 | ED                |        | ATS    | 2 AND          | ) ATS   | 3.           |
|  | ENTICA             | AL TO                                 | THA                                    | AT US                                 | ED                |        | ATS    | 2 AND          | ) ATS   | 3.           |
|  | ENTICA             | AL TO                                 | THA                                    | AT US                                 | ED                |        | ATS    | 2 AND          | ) ATS   | 3.           |
|  | NTICA              | AL TO                                 | THA                                    | AT US                                 | ED                |        | ATS    | 2 AND          | ) ATS   | 3.           |

#### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771

| 1. TITLE             |                   |        |                 |         |                   |       |                   | ACRON  |      | 3. ( | EXP NO          |  |
|----------------------|-------------------|--------|-----------------|---------|-------------------|-------|-------------------|--------|------|------|-----------------|--|
| MICROWAVE            | TPANSPONDER       | ₹      |                 | _       |                   |       | M                 | TRAI   | 4    |      |                 |  |
| (TITLE CONT.         | )                 |        |                 |         |                   |       | 4.1               | RESUME | DATE | П    | 5.<br>VERSION   |  |
|                      |                   |        |                 |         |                   |       | 10,               | 97 C   | 17   |      | 0004            |  |
| 6. PRINCIPAL IN      | NVESTIGATOR       | 7. OR  | GANIZATION      |         |                   | 8. T  | ELEPHO            | NE     |      |      |                 |  |
| DARCEY, F            | ₹.J.              | GODI   | DARD SPACE      | FLT C   | ENTER             | 30    | 301-982-5042      |        |      |      |                 |  |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION      |         |                   | 11. 7 | ELEPH             | ONE    |      |      |                 |  |
|                      |                   |        |                 |         |                   |       |                   |        |      |      |                 |  |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX | NUMBER  | 15. START<br>DATE |       | DATE              |        |      |      |                 |  |
|                      |                   |        |                 |         |                   | 1     | 1/67              | OP     | ER A | TI   | ONAL            |  |
| 18. MONITOR          | <del></del>       | 19. AG | ENCY            | 20. PGN | OFFICE            |       | TELEPH            |        |      |      |                 |  |
| BURKE, J.            | .R.               | NAS    | A HDQTRS        | OA7     | ECS <sub>.</sub>  | 20    | 2-75              | 5-2    | 322  | 2    |                 |  |
| 22. VENDOR           |                   |        | 23. LOCATION    |         |                   |       | 24. FLIGH<br>DATE | 17 2   | 5. L | EAD  | TIME            |  |
| HUGHES A             | IRCRAFT CO        |        | EL SEGUNDO      | , CAL   | IFORN             | ΙA    | 117               | 67     | VA   |      |                 |  |
| 26. INSTRUMEN        | T TYPE            |        |                 |         |                   |       |                   |        |      |      | 27.<br>SECURITY |  |
| TRANSPONE            | DER, 6-GHZ (1     | RECE   | IVE) 4-GHZ      | (TRAN   | SMIT)             | SH    | F                 |        |      |      | UNC             |  |
| 28. APPLICATIO       | N .               |        |                 | 2       | 29. SPACE         | CRAF  | FT                |        |      |      |                 |  |
| COMM                 |                   |        |                 |         | ATS 3             |       |                   |        |      |      |                 |  |
| 30. PURPOSE          |                   |        |                 |         |                   |       |                   |        |      |      |                 |  |
|                      |                   |        |                 |         |                   |       |                   |        |      |      |                 |  |

PRIMARY- TO EVALUATE SIMULTANEOUS TRANSMISSION OF VOICE, TELE-VISION, TELEGRAPH, AND DIGITAL DATA TO SEVERAL GROUND STATIONS. \*\*\*SECONDARY- TO DETERMINE EFFECTS OF DOPPLER SHIFT DUE TO SATELLITE MOTION ON MULTIPLE ACCESS EQUIPMENT AND COMPARE EFFECTS WITH STATIONARY SATELLITE.

#### 31. PRINCIPLES OF OPERATION

SYSTEM IS IDENTICAL TO THAT FLOWN ON ATS 1 AND ATS 2. RECEIVING AND TRANSMITTING ANTENNAS AND TRAVELING-WAVE-TUBE POWER AMPLI-FIERS ARE USED IN CONJUNCTION WITH A DUAL MODE COMMUNICATIONS TRANSPONDER TO PROVIDE A SYSTEM ELEMENT CAPABLE OF ACCEPTING AND HANDLING ANY TYPE OF COMMUNICATIONS TRAFFIC OR WIDEBAND COMMUNI-CATIONS. THE FREQUENCY TRANSLATION MODE IS DESIGNED PRIMARILY FOR TELEVISION OR OTHER WIDEBAND USAGE IN WHICH ONE GROUND TRANSMITTER UTILIZES THE COMPLETE CHANNEL. THE USABLE BANDWIDTH IS 25 MHZ. THE MULTIPLE ACCESS MODE IS DESIGNED TO PERMIT THE INTERCONNECTION OF A LARGE NUMBER OF GROUND STATIONS IN A HIGH CHANNEL CAPACITY FREQUENCY DIVISION MULTIPLEX SYSTEM. THE TRANS-PONDER SERVES AS A TELEPHONE RELAY. FREQUENCY DIVISION MULTI-PLEXING OF THE VOICE CHANNELS WITH SSB IS USED FOR THE VARIOUS GROUND-TO-SPACECRAFT LINKS. THESE SIGNALS ARE CONVERTED INTO PHASE MODULATION OF A SINGLE CARRIER IN THE SPACECRAFT AND ARE RETRANSMITTED TO ALL STATIONS IN THIS FORM. EACH GROUND STATION SELECTS THE APPROPRIATE CHANNELS FROM THE RECOVERED BASEBAND CONTAINING ALL CHANNELS TO COMPLETE THE TWO-WAY INTERCONNEC-TIONS. THE ANTENNA USED IS A MECHANICAL DESPUN PHASED ARRAY, GIVING 15-18 DB OF GAIN. THE AFFECTIVE RADIATED POWER IS 830 W.

#### 32. PHENOMENA OBSERVED

TRANSMISSIONS FROM ATS GROUND STATIONS AT 6 GHZ

#### 33. MEASUREMENT RANGE

| 35. SPECTRAL RANGE   | 36. SPECTRAL RESOLUTION 37. TIME CONSTANT     |
|--|---|
| 6.212 TO 6.301 GHZ   | 25. MHZ                                       |
| 38. FIELD OF VIEW 39. GROUND SW  |   |
|  | LIMB (9500 NM) FROM GEO-SYNCH ALT             |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESOLUTION  |   |
| 42. POINTING ACCURACY 43. POINTING RATE 44. AL   | TITUDE 45. INCLINATION                        |
|  | CH CIRCULAR EQUATORIAL POSIGRADE              |
| 46. SPECIAL REQUIREMENTS   | ON CINCOLAN CACHIONINE COSTOCASE              |
|  |   |
| 47. COMPONENTS   |   |
| TRANSPONDER, ANTENNA   |   |
| 48. WEIGHT 49. VOLUME 50. AVERAGE PO   | WER 51. STANDBY POWER 52. PEAK POWER 53. MTBF |
| RE G. MAGNETIC L. NICLEAR CO.  | THERMAL TO CHARLE DING                        |
|  | THERMAL 58. SHIELDING                         |
| SOURC/SEN SOURCES SOUR | ENSITIVE 61. FREQUENCY OF OBSERVATION         |
|  | ME TELEMETRY CONTINUOUS                       |
| 62. TELEMETRY REQUIREMENTS   | TE TELEPIETON I CONTINUOUS                    |
| NA   |   |
|  |   |
|  |   |
| 63. ADVANTAGES AND LIMITATIONS   | · ·   |
|  |   |
| 64. REFERENCES   |   |
|  | E ND.67-276,00T. 1967.***2) PRO-              |
| JECT DEVELOPMENT PLAN-APPLICATI  |   |
| GREENBELT, MD. ***3) TECHNICAL D   |   |
| GSFC, 1968.  | ATA REPORT FOR THE ATS PROGRAMY               |
|  |   |
|  |   |
| 65. HISTORICAL REMARKS   |   |
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### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER CREENIBLE T MD 20771

|                     |                   |        | GREENBELT, MD.    | 20//1  |                   |       |                    |            |          |                 |  |
|---------------------|-------------------|--------|-------------------|--------|-------------------|-------|--------------------|------------|----------|-----------------|--|
| 1. TITLE            |                   |        |                   |        |                   |       | 2. A               | CRONYM     | 3. 1     | EXP NO          |  |
| NCN-COHER           | RENT C-BAND 1     | rans   | SPONDER           |        |                   |       | NC                 | TRAN       |          |                 |  |
| (TITLE CONT.        | )                 |        |                   |        |                   |       | 4. RI              | ESUME DATE |          | 5.<br>VERSION   |  |
|                     |                   |        |                   |        |                   |       | 0.9                | 7017       | 72       | 0001            |  |
| 6. PRINCIPAL II     | NVESTIGATOR       | 7. OR  | GANIZATION        |        |                   | 8. T  | ELEPHO             | EPHONE     |          |                 |  |
| JACKSON,            | E • B •           | NAS    | SA WALLOPS S      | TATI   | ON                | 703   | 824                | -341       | <u>i</u> |                 |  |
| 9. CO-INVESTIG      | ATOR              | 10. OR | GANIZATION        | 11. T  | ELEPHO            | NE'   |                    |            |          |                 |  |
|                     |                   |        |                   |        |                   |       |                    |            |          |                 |  |
| 12. CONTP T<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX N | JMBER  | 15. START<br>DATE | 16. C | OMPLETION<br>DATE  | 17. STA    | rus      |                 |  |
|                     |                   |        |                   |        |                   |       |                    |            |          |                 |  |
| 18. MONITOR         |                   | 19. AG | ENCY              | 20. PG | M OFFICE          | 21. T | ELEPHO             | ONE        |          |                 |  |
| DILLER, I           | D. S.             | NAS    | SA HDQTS          | OA/    | 'E\$              | 202   | ?-755              | -2322      | 2        |                 |  |
| 22. VENDOR          |                   |        | 23. LOCATION      |        |                   |       | 24. FLIGHT<br>DATE | 25. L      | .EAD     | TIME            |  |
| VEGA PREC           | CISION LABS       |        | VIENNA, VIR       | GINI   | Α                 |       |                    |            |          |                 |  |
| 26. INSTRUMEN       | T TYPE            |        |                   |        |                   |       |                    |            |          | 27.<br>SECURITY |  |
| TRANSPONE           | DER, C-BAND V     | √EGA   | MODEL 313C        |        |                   |       |                    |            |          | UNC             |  |
| 28. APPLICATIO      |                   |        |                   |        | 29. SPACE         | CRAF  | T                  |            |          |                 |  |
| GEOD                |                   |        |                   |        | GEO S:            | -C -  |                    |            |          |                 |  |
| 30. PURPOSE         |                   |        |                   |        |                   |       |                    |            |          |                 |  |
|                     |                   |        |                   |        |                   |       |                    |            |          |                 |  |

PRIMARY - SUPPORT CALIBRATION AND EVALUATION OF GROUND C-BAND RADAR SYSTEMS AND LOCATE THESE STATIONS IN UNIFIED EARTH-CENTERED REFERENC SYSTEM. \*\*\* SECONDARY - PROVIDE TRACKING COVERAGE IN SUPPORT OF RADAR ALTIMETER EXPERIMENT.

#### 31. PRINCIPLES OF OPERATION

THE TRANSPONDER RECEIVES A PAIR OF PULSES 8 MICORSEC APART FROM A GROUND STATION. AFTER THE FIRST PULSE IS RECEIVED AN INTERNAL GATING PULSE IS GENERATED 8 MICROSEC LATER. WHEN THE GATING PULSE IS PRESENT THE SECOND RECEIVED PULSE WILL GENERATE A RETURN PULSE AFTER A FIXED DELAY. RANGING IS OBTAINED AT THE GROUND VIA THE TIME REQUIRED TO MAKE THE ROUNDTRIP LESS THE FIXED DELAY IN THE S/C. MAXIMUM DAILY SCHEDULE OF 65 MINUTE RADIATING TIME PER ORBIT FOR 3 DAYS CONTINUOUSLY.

| 32. PHE | NOMENA OBSE  | RVED   |      |         |          |     |      |     |  |
|---------|--------------|--------|------|---------|----------|-----|------|-----|--|
| RF      | TRANSMIS     | SION   | FROM | GR OUND | STATION  | SAT | 5690 | MHZ |  |
|         | SUREMENT R   |        |      |         |          |     |      |     |  |
|         |              |        |      |         |          |     |      |     |  |
| 34. PRE | CISION AND A | CCURAC | Y    |         |          | •   |      |     |  |
|         |              |        |      |         | RACY 2 M |     |      |     |  |



| 35. SPECTRAL RANGE                     |          |            |          | 36.  | SPECTRA                               | AL RE        | SOLI | JTION             | 37. TIME  | CONSTANT    |
|--|----------|------------|----------|------|---------------------------------------|--------------|------|-------------------|-----------|-------------|
| 5690 (R)TO 5765 (T)                    | МН       | 7          |          |      |                                       |              |      | · · · · · · · · · |           | <u></u>     |
| 38. FIELD OF VIEW                      |          | GROUND     | SWA      | TH   | · · · · · · · · · · · · · · · · · · · |              |      |                   |           |             |
|  | <b>†</b> |            |          |      |                                       |              |      |                   |           |             |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES | OLU      | TION       |          |      |                                       |              |      |                   |           |             |
| NA NA                                  |          |            |          |      |                                       |              |      |                   |           |             |
| 42. POINTING ACCURACY 43. POINTING RAT | E        | 44.        | ALTI     | TU   | DE                                    |              | 45.  | NCLINA            | TION      |             |
| NA NA                                  |          | 92         | 7        | K    | M (MEA                                | N)           | 11:  | DEG               |           |             |
| 46. SPECIAL REQUIREMENTS               |          |            |          |      |                                       |              |      |                   |           |             |
| OPERABLE SIMULTANEOUSL                 | Y        | WITH       | COH      | ER   | ENT T                                 | RNA          | SPO  | INDER             |           |             |
| 47. COMPONENTS                         |          |            |          |      |                                       |              |      |                   |           |             |
| VEGA MODEL 313C TRANSP                 | ON       | DER        |          |      |                                       |              |      |                   |           |             |
| 48. WEIGHT 49. VOLUME                  | -        | D. AVERAG  | E POWE   | R    |                                       |              |      |                   | K POWER   | 53. MTBF    |
| 4 LB 8.334CU FT                        |          |            |          |      | 4 W                                   |              |      |                   | WATTS     |             |
| 54. INTERFERENCE 55. MAGNETIC 56. INTE | RFERE    | AR<br>ENCE | 57. INTE | RFER | AL<br>ENCE                            | 58. S        | HIEL | DING              |           |             |
| SOURCE                                 |          |            |          |      |                                       |              |      |                   |           |             |
| 59. CALIBRATION                        |          | 60. DATA   | A REC    | OV   | ERY                                   |              |      | 61. FRE           | QUENCY OF | OBSERVATION |
| NONE                                   |          | NA         |          |      |                                       | ************ |      | 1                 |           |             |
| 62. TELEMETRY REQUIREMENTS             |          |            |          |      |                                       |              |      |                   |           |             |
| COMMAND-OFF, ON-NORMAL                 |          |            |          |      |                                       |              |      |                   |           |             |
| TELEMETRY-6 PARAMETERS                 | A        | ND 2       | MOD      | E    | INDIC                                 | ATI          | 045  | DNC               | E/MIN     |             |
| CO ADVANTAGES AND LIMITATIONS          |          |            |          |      |                                       |              |      |                   |           |             |
| 63. ADVANTAGES AND LIMITATIONS         |          |            |          |      |                                       |              |      |                   |           |             |
|  |          |            |          |      |                                       |              |      |                   |           |             |
| 64. REFERENCES                         |          |            |          |      |                                       |              |      |                   |           |             |
|  |          |            | 0.50     |      |                                       |              |      |                   |           |             |
| GEOS-C SPACECRAFT EXPE                 | RI       | A F M I    | REQ      | IJΙ  | REMEN                                 | 15           | 030  | UMEN              | T, RE     | / 1,        |
| 12 MAY 1972.                           |          |            |          |      |                                       |              |      |                   |           |             |
|  |          |            |          |      |                                       |              |      |                   |           |             |
|  |          |            |          |      |                                       |              |      |                   |           |             |
|  |          |            | *        |      |                                       |              |      |                   |           | •           |
| 65. HISTORICAL REMARKS                 |          |            |          |      |                                       |              |      |                   |           |             |
| SAME AS COHERENT TRANS                 | D ON     | IDED       | TN /     | CE   | 05-2                                  |              |      | - · · · · ·       |           |             |
| SAME AS COHERENT TRANS                 | POI      | YUER       | I IN     | O E  | <u> </u>                              |              |      |                   |           |             |
| 1                                      |          |            |          |      |                                       |              |      |                   |           | i           |
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|  |          |            |          |      |                                       |              |      |                   |           |             |
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|                      |                  |        | GITCEITDEET, IND. 1 | -0,,,   |                   |       |                    |            |              |                 |
|----------------------|------------------|--------|---------------------|---------|-------------------|-------|--------------------|------------|--------------|-----------------|
| 1. TITLE             |                  |        |                     |         |                   |       | 2. 4               | CRONYM     | 3.           | EXP NO          |
| OPTICAL              | BEACON           |        |                     |         |                   |       | 0.8                | EAC        |              |                 |
| (TITLE CONT          | .)               |        |                     |         |                   |       | 4. RI              | ESUME DATE |              | 5.<br>VERSION   |
|                      |                  |        |                     |         |                   |       | 0.9                | 7017       | 72           | 0004            |
| 6. PRINCIPAL II      | NVESTIGATOR      | 7. OR  | GANIZATION          |         |                   | 8. T  | ELEPHO             | NE         |              |                 |
| BERBERT,             | J.H.             | GODI   | DARD SPACE FI       | LTC     | ENTER             | 301   | L-982              | -504       | 2            |                 |
| 9. CO-INVESTIC       | GATOR            | 10. OR | GANIZATION          |         |                   | 11. T | ELEPHO             | NE         |              |                 |
|                      |                  |        |                     |         |                   |       |                    |            |              |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUM | BER    | 14. FLASH INDEX NU  | MBER    | 15. START<br>DATE | 16. C | OMPLETION DATE     | 17. STA    | TUS          |                 |
|                      |                  |        |                     |         |                   |       |                    | OPER       | <u>Δ Τ :</u> | IONAL           |
| 18. MONITOR          |                  | 19. AG | ENCY                | 20. PGN | OFFICE            | 21. T | ELEPHO             | ONE        |              |                 |
| ROSENBER             | G, J.D.          | NAS    | A HDQTRS            | OA/     | ECD               | 202   | 2-755              | -232       | 2            |                 |
| 22. VENDOR           |                  |        | 23. LOCATION        |         |                   | •     | 24. FLIGHT<br>DATE | 25. ا      | EA           | D TIME          |
| E. G. AN             | D G., INC.       |        | BEDFORD, MA         | SS      |                   |       | 01/6               | 8 NA       |              |                 |
| 26. INSTRUMEN        | IT TYPE          |        |                     |         |                   |       |                    |            |              | 27.<br>SECURITY |
| BEACON.              | FOUR HIGH-IN     | TENS   | ITY XENON-FL        | ASH-    | TUBE              |       |                    |            |              | UNC             |
| 28. APPLICATIO       | N                |        |                     | 2       | 9. SPACE          | CRAF  | T                  |            |              |                 |
| GEOD                 |                  |        |                     |         | GEOS 2            | 2     |                    |            |              |                 |
| 30. PURPOSE          |                  |        |                     |         |                   |       |                    |            |              |                 |

PRIMARY-TO OBTAIN GEOMETRIC TRIANGULATION OF INTERVISIBLE POINTS ON THE EARTH'S SURFACE.\*\*\*SECONDARY-TO OBTAIN PRECISE ANGLE MEASUREMENTS.

#### 31. PRINCIPLES OF OPERATION

THE OPTICAL BEACONS ARE USED IN CONJUNCTION WITH A LARGE NUMBER OF GROUND-BASED CAMERA SYSTEMS WHICH SIMULTANEOUSLY PHOTOGRAPH THE BEACONS AGAINST A STAR BACKGROUND. THE BEACON SYSTEM CON-SISTS OF 4 IDENTICAL HELICALLY-WOUND FLASH TUBES FILLED WITH MAXIMUM LIGHT LEVELS AT GROUND STATIONS OCCUR WHEN XENON GAS. THE SATELLITE IS SEEN BETWEEN 35 AND 55 DEG ELEVATION ANGLE. THIS BEACON SYSTEM WITH 4 LAMPS FLASHED SIMULTANEOUSLY IS SUIT-ABLE FOR OPERATIONAL ALTITUDES UP TO 1000 NM. THE LIGHT CUTPUT IS 1580 CANDLE-SECONDS FOR EACH FLASH TUBE OR APPROXIMATELY 6300 CANDLE-SECS FOR ALL 4 TUBES FLASHING SIMULTANEOUSLY. THE NOMI-NAL FLASH DURATION IS 1 MILLISECOND BETWEEN 30% INTENSITY IN TERMS OF POWER, BETWEEN 610 AND 950 INDIVIDUAL LAMP POINTS. FLASHES PER DAY ARE AVAILABLE. THE ENERGY USED IN A SINGLE FLASH IS 720 WATT-SEC. EACH FLASH TUBE IS EXPECTED TO HAVE A FLASH INTENSITY OF AT LEAST 50% OF ITS INITIAL VALUE AFTER 40,000 FLASHES. THE PROGRAMMED FLASH TIMES AND NUMBER OF TUBES TO BE FLASHED ARE INJECTED INTO THE SATELLITE MEMORY, BY THE ROSMAN GROUND STATION, ON A DAILY BASIS.

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|----------------------------|---|
| 32. PHENOMENA OBSERVED     | , |
| NA                         |   |
| 33. MEASUREMENT RANGE      |   |
|                            |   |
| 34. PRECISION AND ACCURACY |   |
|                            |   |

| 35. SPECTRAL RANGE                      |                                       | 36. SPECTRAL RE                       | SOLUTION    | 37. TIME CONSTANT                     |
|---|---------------------------------------|---------------------------------------|-------------|---------------------------------------|
| NA                                      |                                       | NA                                    |             |                                       |
| 38. FIELD OF VIEW                       | 39. GROUND SWA                        | TH                                    |             |                                       |
| NA                                      | NA                                    |                                       |             |                                       |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES  | OLUTION                               |                                       |             |                                       |
| NA NA                                   |                                       |                                       |             |                                       |
| 42. POINTING ACCURACY 43. POINTING RAT  |                                       |                                       | 45. INCLINA | RETROGRADE                            |
| NA L                                    | MED                                   | ECCENTRIC                             | HIGH        | KEINUGNADE                            |
| 46. SPECIAL REQUIREMENTS                |                                       | · · · · · · · · · · · · · · · · · · · |             | · · · · · · · · · · · · · · · · · · · |
| 47. COMPONENTS                          | <del></del>                           | . 22                                  |             |                                       |
| FOUR FLASH TUBES, BATT                  | FRY                                   |                                       |             |                                       |
| 48. WEIGHT 49. VOLUME                   | 50. AVERAGE POW                       | ER 51. STANDBY POV                    | VER 52. PEA | K POWER 53. MTBF                      |
| 80 LB                                   | 8 WAT                                 |                                       |             | WATTS                                 |
|   |                                       |                                       | HIELDING    |                                       |
| NONE NONE NO                            |                                       |                                       | VE.         |                                       |
| 59. CALIBRATION                         | 60. DATA REC                          | OVERY                                 | 61. FRE     | QUENCY OF OBSERVATION                 |
| NONE                                    | NA                                    |                                       | 40          | SEQUENCES/DAY                         |
| 62. TELEMETRY REQUIREMENTS              |                                       |                                       |             |                                       |
| NONE                                    | -                                     |                                       |             | ,                                     |
|   |                                       |                                       |             |                                       |
|   | · · · · · · · · · · · · · · · · · · · |                                       | -x          |                                       |
| 63. ADVANTAGES AND LIMITATIONS          |                                       |                                       |             |                                       |
|   |                                       |                                       |             |                                       |
| O. DESERVAÇÃO                           |                                       |                                       |             |                                       |
| 64. REFERENCES  1) NASA PRESS KIT FOR G | EOC-B DEI                             | EACE NO. A                            | 9-2K. 1     | AN 7. 68.***21                        |
| PARAMETRIC ANALYSIS FOR                 |                                       |                                       |             |                                       |
| REPORT NO: R-4035-50-2                  |                                       |                                       |             |                                       |
| NET ON 1 NO. N 4033 30 2                | , 00/11/0/120                         | ATTOMS AND                            | 0.0.0       |                                       |
|   |                                       |                                       | •           | J                                     |
|   |                                       |                                       |             |                                       |
| 65. HISTORICAL REMARKS                  |                                       | ,                                     |             | ,                                     |
| GEOS 2 IS ALSO KNOWN A                  | S EXPLORER                            | 36.                                   |             |                                       |
|   |                                       |                                       |             |                                       |
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|----------------------|-------------------|--------|---------------------|-------------|-------------------|------------------|------------------|----------|--------|------|-----------------|
| 1. TITLE             |                   |        |                     |             |                   |                  | 2                | . ACR    | ŅYNC   | 3. 8 | XP NO           |
| OMEGA PO:            | SITION-AND-LO     | CAT    | ION EQUIPMENT       | E)          | KPERIME           | ENT              |                  | PLE      |        |      |                 |
| (TITLE CONT.         | .)                |        |                     |             |                   |                  | 4                | RESUM    | E DATE |      | 5.<br>VERSION   |
|                      |                   |        |                     |             |                   |                  |                  | 9/(      | 01/7   | 2    | 0004            |
| 6. PRINCIPAL II      | NVESTIGATOR       | 7. OR  | GANIZATION          |             |                   | 8. TI            | ELEPH            | ONE      |        |      |                 |
| LAUGHLIN             | , C.              | GODE   | DARD SPACE FL       | . T _ (     | CENTER            | 30               | 1-98             | 32-9     | 5042   |      |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION          |             |                   | 11. T            | ELEP             | IONE     |        |      |                 |
| HILTON,              | G.E.              | GODE   | DARD SPACE FL       | Τ (         |                   |                  |                  |          | 5042   |      |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NUI | <b>MBER</b> | 15. START<br>DATE | 16. <sup>C</sup> | OMPLETIC<br>DATE | ™ 17.    | STAT   | US   |                 |
| _                    |                   |        |                     |             |                   | 11               | 1/67             | 10       | PERA   | TI   | ONAL            |
| 18. MONITOR          |                   | 19. AG | ENCY                | 20. PG      | M OFFICE          | 21. T            | TELEP            | HONE     |        |      |                 |
| BURKE, J             | .R                | NAS    | A_HDQTRS            | OA/         | /ECS              | 20               | 2-75             | 55-7     | 2322   |      |                 |
| 22. VENDOR           |                   |        | 23. LOCATION        |             |                   |                  | 24. FLH<br>DAT   | SHT<br>E | 25. LI | EAD  | TIME            |
| HUGHES A             | IRCRAFT CO        |        | EL SEGUNDO,         | CAL         | IFORN             | ΙΔ               | 11/              | 67       | NA     |      |                 |
| 26. INSTRUMEN        | IT TYPE           |        |                     |             |                   |                  |                  |          |        |      | 27.<br>SECURITY |
| TRANSPON             | DER, VHF          |        |                     |             |                   |                  |                  |          |        |      | UNC             |
| 28. APPLICATIO       | N .               |        |                     |             | 29. SPACE         | CRAF             | Т                |          |        |      |                 |
| MET. OCE             | AN, NAV           |        |                     |             | ATS 3             |                  |                  |          |        |      |                 |
|                      |                   |        |                     |             |                   |                  |                  |          |        |      |                 |

30. PURPOSE

PRIMARY - TO DEMONSTRATE THE FEASIBILITY OF USING THE OMEGA NAVIGATIONAL SYSTEM IN CONJUNCTION WITH SYNCHRONOUS SATELLITES TO ESTABLISH A GLOBAL LOCATION AND DATA COLLECTION SYSTEM.

#### 31. PRINCIPLES OF OPERATION

AN OPERATIONAL SYSTEM CONSISTS OF: (1) AN OPLE CONTROL CENTER; (2) A SYNCHRONOUS SATELLITE; AND (3) THE OPLE PLATFORM ELECTRONIC PACKAGES (PEP'S) WORKING IN CONJUNCTION WITH THE OMEGA NETWORK. DURING A TYPICAL INTERROGATION PERIOD, GSFC TRANSMITS A PRE-PRO-GRAMMED PLATFORM INTERROGATION SEQUENCE WHICH IS RELAYED (VHF) VIA ATS TO OPLE PLATFORMS. THE ATS 3 VHF TRANSPONDER RECEIVES AT 149.22 MHZ AND TRANSMITS AT 135.6 MHZ WITH A 40-WATT MAX OUT-PUT. IT CAN OPERATE ALSO IN THE 450 MHZ BAND. EACH PLATFORM HAS ITS OWN BINARY CODE ADDRESS. AFTER RECEIPT OF THEIR OWN PROPER ADDRESSES. THE CORRECTLY ADDRESSED PEP'S SIMULTANEOUSLY TRANSMIT THEIR ASSIGNED ACQUISITION REFERENCE A/R SIGNALS. AFTER THE ACQUISITION PERIOD, THE A/R TONE IS MODULATED WITH METEORO-LOGICAL OR PLATFORM STATUS DATA BY PHASE-SHIFT KEYING. ING THE DATA TRANSMISSION PERIOD. THE A/R TONE IS REDUCED IN POWER LEVEL AND THE OMEGA TRANSMISSION MODE IS INITIATED. THIS MODE, TWO PAIRS OF VLF OMEGA SIGNALS ARE RECEIVED BY THE RECEIVERS ON THE PLATFORMS AND CONVERTED TO VHF FOR TRANSMISSION TO ATS 3 AND THEN GODDARD. THE RELATIVE PHASE BETWEN THE TWO SIGNALS OF A PAIR DETERMINE A LINE AND THE INTERSECTION OF THE 2 LINES GIVE THE LOCATION TO WITHIN 1 MI (DAYTIME). 2 MI (NIGHT).

32. PHENOMENA OBSERVED

DATA FROM OBSERVATION PLATFORMS

33. MEASUREMENT RANGE

34. PRECISION AND ACCURACY

POSITION TO ONE MILE IN DAYTIME: TWO MILES NIGHTIME

| 35. SPECTRAL RANGE                       |             |                  |              | 36.   | SPECTR      | AL RE        | SOLL      | JTION         | 37. TIME    | CONSTA                                | NT     |
|--|-------------|------------------|--------------|-------|-------------|--------------|-----------|---------------|-------------|---------------------------------------|--------|
| SEE ITEM 31                              |             |                  |              |       |             |              |           |               |             |                                       |        |
| 38. FIELD OF VIEW                        |             | 39. GROL         |              |       |             |              |           |               |             |                                       |        |
|  |             |                  | 10-L         | IMI   | 3 (100      | O NI         | 1)        | FROM          | GED-S       | YNCH                                  | ALT    |
| 40. ANGULAR RESOLUTION 41, SPATIAL       | HESO        | LUTION           |              |       |             |              |           |               |             |                                       |        |
| NA NA 42. POINTING ACCURACY 43. POINTING | RATE        | <u>-</u>         | 44. ALT      | T1 11 |             |              | 45 '      | NCLINA        | TION        |                                       |        |
| 4. DEG                                   | MAIE        |                  |              |       |             | ΙΛR          |           |               | RIAL P      | ons i a                               | RADE   |
| 46. SPECIAL REQUIREMENTS                 |             | <u></u> <u>L</u> | 31:40        | •     | JINCO       | <u> </u>     | L 04      | 04101         | <u> </u>    | 0010                                  | TADE   |
|  |             |                  |              |       | <u> </u>    | _            |           |               | <del></del> |                                       |        |
| 47. COMPONENTS                           |             |                  |              |       |             |              |           |               |             | 1                                     |        |
| PLATFORM ELECTRONIC                      | PAC         | KAGES            | , BA         | TT    | ERY,        | DIP          | )LE       | ANTI          | ENNA.       |                                       |        |
| 48. WEIGHT 49, VOLUME                    |             | 50. AVE          | RAGE POW     | ER    | 51. STANI   | DBY POV      | VER       | 52. PEA       | KPOWER      | 53. M1                                | BF     |
| 45 LB                                    |             | 90               |              |       |             | ·            | L         |               |             | ]                                     |        |
| 54. INTERPERENCE S5. MAGNETIC            | 56. INTER   | CLEAR<br>FERENCE | 57. INT      | HERM  | AL<br>ENCE  | 58. S        | HIEL      | DING          |             |                                       |        |
| SOURC/SEN                                |             | 100 0            |              |       |             | <u> </u>     | ,         | T             |             | OBSERVA.                              | T.01   |
| 59. CALIBRATION                          | <del></del> |                  | ATA REC      | .ov   | ERY         |              |           | 1             | DENCY OF    |                                       | I ION  |
| NA<br>62. TELEMETRY REQUIREMENTS         |             | NA_              |              |       |             |              |           | IAS I         | PROGRA      | AMMEU                                 |        |
| 56 BITS PER SECOND.                      |             | SE CL            | ITET         | KEY   | VED         | <del>-</del> | ,         | cas and comme |             | ت حساسي و سينت                        | * 1    |
| DO DES FER SECUNDA                       | TITA        | JE JE            | , g ( ¥ )    | \ C   |             |              |           |               |             |                                       |        |
|  |             |                  |              |       |             |              |           |               |             |                                       |        |
| 63. ADVANTAGES AND LIMITATION            | VS          |                  |              |       |             |              |           |               |             | · · · · · · · · · · · · · · · · · · · | 1      |
| COMPLEX AND BULKY LO                     | CAT         | ION-C            | OMPU         | TI    | NG EQ       | UIP          | 1E V      | T CA          | V BE L      | OCAT                                  | ED AT  |
| CONVENIENT CENTER RA                     | THE         | R THA            | N AT         | PI    | LATEO       | RM.          |           |               |             |                                       | ]      |
| 64. REFERENCES                           |             |                  |              |       |             |              |           |               |             |                                       |        |
| 1) ATS C PRESS KIT,                      | ATS         | VOL              | 1-6,         | N,    | ASA R       | ELE          | <b>SE</b> | NO.           | 67-27       | 6, 0                                  | CT ]   |
| 1967.***2) ATS TECH                      |             |                  |              |       | -           |              |           |               |             |                                       | 1      |
| TER, GREENBELT, MD.                      |             |                  |              | -     |             |              |           |               |             |                                       |        |
| ET AL: OMEGA POSITION                    |             |                  |              |       |             |              |           |               |             | ITED .                                | AT     |
| ATS SYSTEMS ENGRS TE                     | RAIN        | ING P            | ROGR         | ДΜ    | • GSF       | С,           | SEP       | τ. 19         | 966.        |                                       |        |
| 65. HISTORICAL REMARKS                   |             |                  |              |       | <del></del> |              |           |               |             | e e                                   |        |
| OS. MOTOMORE NEWANKS                     |             |                  |              |       |             |              |           | <del>-</del>  |             |                                       | الن بي |
| <del></del>                              | ·           |                  | <del> </del> |       |             |              | · -       |               |             | <del></del>                           |        |
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|----------------------|-------------------|--------|---------------------------------------|---------|-------------------|----------|---|-----------|------|-----------------|
| 1. TITLE             |                   |        |                                       |         |                   |          | 2. A                                    | CRONYM    | 3. E | XP NO           |
| POSITION             | LOCATION AND      | ) AIF  | RCRAFT COMMUN                         | ICA     | TIONS             |          | PLA                                     | ACE       | NΔ   |                 |
| (TITLE CONT.         | )                 |        |                                       |         |                   |          | 4. RE                                   | SUME DATE | 5    | ERSION          |
|                      |                   |        |                                       |         |                   |          | 09,                                     | /01/7     | 2 0  | 004             |
| 6. PRINCIPAL II      | VESTIGATOR        | 7. OR  | GANIZATION                            |         |                   | 8. T     | ELEPHON                                 | VE        |      |                 |
| LAUGHLIN             | C. R.             | GODE   | DARD SPACE FL                         | T C     | ENTER             | 301      | -982                                    | -5042     | '    |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZATION                            |         |                   |          | ELEPHO                                  |           |      |                 |
| ALLEN, W.            |                   | GODE   | DARD SPACE FL                         | T C     | ENTER             | 301      | -982                                    | -5042     |      |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NUN                   | MBER    | 15. START<br>DATE | 16. C    | OMPLETION DATE                          | 17. STAT  | US   |                 |
|                      |                   |        |                                       |         | 11/67             | <u>'</u> |   |           |      |                 |
| 18. MONITOR          |                   | 19. AG | ENCY                                  | 20. PGN | OFFICE            | 21. T    | ELEPHO                                  | NE        |      |                 |
| BURKE, J.            | .R.               | NASA   | A HDQTRS                              | OA/     | ECS               | 202      | 755                                     | -2322     |      |                 |
| 22. VENDOR           |                   |        | 23. LOCATION                          |         |                   |          | 24. FLIGHT<br>DATE                      | 25. L     | EAD  | TIME            |
|                      |                   |        |                                       |         |                   |          |   |           |      |                 |
| 26. INSTRUMEN        | T TYPE            |        |                                       |         |                   |          |   |           |      | 27.<br>SECURITY |
| TRANSPOND            | ER, 1.6 AND       | 8.10   | GHZ RECEIVE.                          | 1.5     | AND 7             | .3G      | HZ TI                                   | RANSM     | IT   | UNC             |
| 28. APPLICATIO       | N                 |        |                                       |         | 29. SPACE         | CRAF     | T                                       |           |      |                 |
| NAV, COMM            | 1                 |        |                                       |         | ATS-F             |          |   |           |      |                 |
| 30. PURPOSE          |                   |        |                                       |         |                   |          | *************************************** |           |      |                 |

PRIMARY-TO DETERMINE THE CAPABILITIES OF SYNCHRONOUS SATELLITES TO RELAY COMMUNICATION AND NAVIGATION INFORMATION BETWEEN GROUND AND INFLIGHT AIRCRAFT\*\*\*SECONDARY-TO DETERMINE THE ACCURACY OF SEVERAL POSITION LOCATION TECHNIQUES USING SYNCHRONOUS SATEL-LITES.

#### 31. PRINCIPLES OF OPERATION

IN THIS EXPERIMENT THE SATELLITE RELAYS VOICE AND DIGITAL INFOR-MATION BETWEEN THE GROUND AND FLYING AIRCRAFT. IN ADDITION TO NORMAL COMMUNICATIONS, NAVIGATION SIGNALS ARE RELAYED BY ATS-F FROM AIRCRAFT TO A GROUND CONTROL CENTER FOR POSITION DETERMIN-ATION. A DUAL SATELLITE RANGE-RANGE POSITION LOCATION METHOD MAKING NEAR SIMULTANEOUS RANGE MEASUREMENTS THROUGHT THE USE OF ATS-E AND -F IS INCLUDED. COMMUNICATION TESTS USE THE MULTIPLE ACCESS MODE IN WHICH THE PRIMARY GROUND STATION TRANSMITS A MULTI-CHANNEL SIGNAL AT 8.1 GHZ, CONTAINING BOTH VOICE AND DIGI-TAL DATA. 2 ADDITIONAL GROUP STATIONS ALSO TRANSMIT VOICE IN THIS BAND TO THE SATELLITE. AT THE SATELLITE THE INCOMING SIG-NALS ARE DEMODULATED AND THE RESULTING SIGNAL IS PHASE MODULATED ONTO A 1.55 GHZ CARRIER GENERATED ON-BOARD AND PHASE-LOCKED TO THE PRIMARY GROUND STATION CARRIER, MAINTAINING SIGNAL COHERENCE UP TO 200 AIRCRAFT TRANSMIT TONES. DIGITAL DATA. AND ANALOG VOICE TO THE SATELLITE AT ABOUT 1.65 GHZ. THE SATELLITE PRO-CESSES THESE SIGNALS IN MUCH THE SAME WAY AS THE RECEIVED SIG-NALS FROM THE GROUND AND RETRANSMITS THEM TO THE GROUND AT ABOUT 7.5 GHZ.

#### 32. PHENOMENA OBSERVED

ADDRESS-CODED RF TRANSMISSION FROM NASA GROUND STATIONS AND A/C 33. MEASUREMENT RANGE

RECEIVER NOISE FIGURE DOES NOT EXCEED 5 DB .

34. PRECISION AND ACCURACY

| 35. SPECTRAL      | RANGE    |                        |        |         |            |        | 36             | . SPECTE    | RAL RE  | SOLU        | TION        | 37. TIME       | CONSTANT    |
|-------------------|----------|------------------------|--------|---------|------------|--------|----------------|-------------|---------|-------------|-------------|----------------|-------------|
| 1550.0            | 7        | 0 8                    | 250    | •       | MH         | IZ     |                | 250.        |         | HZ          |             | 150            | O MSEC      |
| 38. FIELD OF V    | IEW      |                        |        | 3       | 9. GRC     | UND S  | WATH           |             |         |             |             |                |             |
| 28.               | BY       | 28                     |        |         |            | 00 N   | M              |             |         |             |             |                |             |
| 40. ANGULAR RES   | DLUTION  | 41. SPA                | TIAL   | RESOL   | UTION      |        |                |             |         |             |             |                |             |
| NΔ                |          | NA                     |        |         |            |        |                |             |         |             |             |                |             |
| 42. POINTING ACCU | JRACY    | 43. POIN               | TING   | RATE    |            | 44. AL | TITU           | DE          |         | 45.11       | NCLINA      | TION           |             |
| NA                |          | NΑ                     |        |         |            | GEO    | /SY            | NCH         |         | 0           |             | מ              | EG          |
| 46. SPECIAL RE    | QUIRE    | MENTS                  |        |         | · ·        | •      |                |             |         |             |             |                |             |
|                   |          |                        |        |         |            |        |                |             |         |             |             |                |             |
| 47. COMPONEN      |          |                        |        |         |            |        |                |             |         |             |             |                |             |
| 2 HORN A          | NTEN     | INAS,                  | 30     | FT      |            |        |                |             |         |             |             | <u>NSCET /</u> | /ER         |
| 48. WEIGHT        | 49. VC   | LUME                   |        |         |            |        |                |             | IDBY PO | WER !       | 52. PEA     | K POWER        | 53. MTBF    |
|                   | <u> </u> | <u> </u>               |        |         |            | O WA   |                | I           |         | L           |             |                | ·           |
| 54. INTERFERENCE  | _        | MAGNETIC<br>TERFERENCE |        | 56. NUC | ERENCE     |        | THERN          |             |         | SHIEL       | DING        |                |             |
| SOURCE/S          |          |                        |        |         |            |        |                | ITIV        |         |             |             |                |             |
| 59. CALIBRATI     | ON       |                        |        |         |            | DATA R |                | ERY         |         |             | 61. FRE     | QUENCY OF      | OBSERVATION |
|                   |          |                        |        |         | <u> RE</u> | ALTI   | ME             |             |         |             |             | <del></del>    |             |
| 62. TELEMETR      | Y REQI   | JIREMEI                | VTS    |         |            |        |                |             |         |             |             |                |             |
|                   |          |                        |        |         |            |        |                |             |         |             |             |                |             |
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|                   |          |                        |        |         | ·          |        |                | <del></del> |         | <del></del> |             |                |             |
| 63. ADVANTAG      |          |                        |        |         |            |        |                |             |         |             |             |                |             |
| INCORPOR          |          |                        |        |         |            |        |                |             |         |             | EREN        | TREFE          | RENCE       |
| SOURCE F          |          | REQU                   | ENCY   | TR      | ANSL       | ATIO   | N C            | IRCU        | 115.    |             |             | <del> </del>   |             |
| 64. REFERENCE     |          | 001+                   | T 0 1  | 1115    | 110        | 6675   | <del>-</del> - | <u> </u>    |         |             |             |                | T 101165    |
|                   |          |                        |        |         |            |        |                |             |         |             |             |                | T (PLACE)   |
| i .               |          |                        | _      | -       | ,          |        |                |             |         |             |             |                | O POSIT-    |
|                   |          |                        |        |         |            |        |                | ATIU        | 15 E    | XPE         | RIME        | NI DIS         | CRIPTION    |
| ( 6SFC X          | -133     | -61-                   | )      | , др    | KIL        | 1969   | •              |             |         |             |             |                |             |
|                   |          |                        |        |         |            |        |                |             |         |             |             |                |             |
| 65. HISTORICA     | DCM      | ARKS                   |        |         |            |        |                |             |         | ·           | <del></del> |                |             |
| CAN USE           |          |                        | T LI C | OME     | MOD        | TETC   | ATI            | ON AL       | UD I    | NC 3        | UEDE        | NT COL         | ID C E      |
| CAN USE           | AI3      | .2 M.T                 | 1 17 3 | SUM E   | MUU        | 1710   | AII            | JIN AI      | VO I    | NUJ         | HEKE        | N 1 300        | IK.CE.      |
|                   |          |                        |        |         |            |        |                |             |         |             |             |                |             |
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| )                 |          |                        |        |         |            |        |                |             |         |             |             |                |             |
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| 1                 |          |                        |        |         |            |        |                |             |         |             |             |                |             |

#### INSTRUMENT RESUME

#### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER

GREENBELT, MD. 20771

| 1. TITLE                                    |        |                    |         |                   |        | 2. /              | ACRONYM    | 3. E | XP NO           |
|---|--------|--------------------|---------|-------------------|--------|-------------------|------------|------|-----------------|
| RADIO FREQUENCY INTER                       | FERE   | ENCE MEASUREM      | 1ENT    |                   |        | RF                | IM         | NA   |                 |
| (TITLE CONT.)                               |        |                    |         |                   |        |                   | ESUME DATE |      | 5.<br>VERSION   |
|   |        |                    |         |                   |        | 105               | 7017       | 72   | 0004            |
| 6. PRINCIPAL INVESTIGATOR                   | 7. OR  | GANIZATION         |         |                   | 8. TE  | LEPHO             | NE         |      |                 |
| HENRY, V. F. GODDARD SPACE FLT CENTER 301-9 |        |                    |         |                   |        |                   |            | 2    |                 |
| 9. CO-INVESTIGATOR                          |        | GANIZATION         |         |                   | 11. TI | ELEPHO            | NE         |      |                 |
| BOUCHER, R. A.                              | HUGI   | HES AIRCRAFT       | COM     |                   |        |                   |            |      |                 |
| 12. CONTRACT NUMB                           | ER     | 14. FLASH INDEX NU | MBER    | 15. START<br>DATE | 16. CC | MPLETION<br>DATE  | 17. STA    | rus  |                 |
| NAS5-11657                                  |        |                    |         |                   |        |                   |            |      |                 |
| 18. MONITOR                                 | 19. AG | ENCY               | 20. PGN | OFFICE            | 21. T  | ELEPHO            | ONE        |      |                 |
| BURKE, J.R.                                 | NAS    | A HDQTPS           | DAI     | ECS               | 202    | 755               | 5-2322     | 2    |                 |
| 22. VENDOR                                  |        | 23. LOCATION       |         |                   |        | 24. FLIGH<br>DATE | ⊺ 25. L    | EAD  | TIME            |
| HUGHES AIRCRAFT COMPA                       | YNY    |                    |         |                   |        |                   |            |      |                 |
| 26. INSTRUMENT TYPE                         |        |                    |         |                   |        |                   |            |      | 27.<br>SECURITY |
| TRANSPONDER, MICROWAY                       | /E,    | 6 GHZ RECEIVE      | E, 4    | GHZ               | TRAN   | IME               | Γ          |      | UNC             |
| 28. APPLICATION                             |        |                    |         | 29. SPACE         | CRAF   | T                 |            |      |                 |
| COMM  |        |                    |         | ATS-F             |        |                   |            |      |                 |
| 30. PURPOSE                                 |        |                    |         |                   |        |                   |            |      |                 |

PRIMARY-TO INVESTIGATE SPECTRUM SHARING BETWEEN SATELLITE TELECOMMUNICATION SYSTEMS AND TERRESTRIAL POINT-TO-POINT RADIO RELAY SYSTEMS IN THE 4 GHZ AND 6 GHZ COMMON CARRIER BANDS.

#### 31. PRINCIPLES OF OPERATION

THIS EXPERIMENT CONCISTS OF RECEPTION AND RETRANSMISSION OF TERRESTRIAL MICROWAVE SIGNALS BY A SYNCHRONOUS SATELLITE. THE TERRESTRIAL SIGNALS IN THE SHARED FREQUENCY BAND ARE RE-CEIVED AT THE SATELLITE AND THEN TRANSMITTED TO A SATELLITE CROUND STATION FOR MEASUREMENT OF FREQUENCY, AMPLITUDE, PULSE WIDTH, AND PULSE REPETITION FREQUENCY, AS WELL AS ANALYSIS OF SOURCE LOCATION. THE INSTRUMENT IS A BROADBAND, SINGLE-CONVER-SION LINEAR REPEATER UTILIZING THE SATELLITE'S 30-FT PARABOLIC DISH ANTENNA AND RECEIVING AT 5925 TO 6425 MHZ AND TRANSMITTING AT 3700 TO 4200 MHZ. THE RECEIVED SIGNALS ARE AMPLIFIED BY TUNNEL DIODE AMPLIFIERS, DOWN-CONVERTED TO THE TRANSMIT FREQUEN-CY AND FURTHER AMPLIFIED BY TRAVELLING WAVE TUBES. A NOTCH FILTER REJECTS RADAR TRANSMISSION ADJACENT TO THE RECEIVER FREQUENCY. THE GROUND RECEIVER CAN BE EITHER THE ROSEMAN. N.C. FACILITY OR A TRANSPORTABLE EARTH TERMINAL.

#### 32. PHENOMENA OBSERVED

RADIATION EMITTED FROM ALL TERRESTRIAL SOURCES IN THE 6 GHZ BAND

33. MEASUREMENT RANGE

INTERFERENCE SOURCE OF 5-10 DBW EIRP DETECTABLE; 40 DB DYN RANGF

34. PRECISION AND ACCURACY

RECEIVER NOISE FIGURE-7 DB MAX

| 35. SPECTRAL RANGE                                       |             |         | 36. 9 | PECTRA   | AL RE         | SOLUTIO     | N    | 37. TIME ( | CONSTANT    |
|--|-------------|---------|-------|----------|---------------|-------------|------|------------|-------------|
| 5925.0 TO 6425.0   | MHZ         | 7       | 10    | • 0      | 1             | KHZ         |      |            |             |
| L  |             | UND SWA |       |          |               |             |      |            |             |
| 35.0 BY 35.0 DEG   | LIMB-       | -TO-L   | MH    | (85)     | 00            | VM)         |      |            | <u> </u>    |
| 40. ANGULAR RESOLUTION 41. SPATIAL RESO                  |             |         |       |          |               |             |      |            |             |
| 0.1 DEG 50 MILES IN                                      | E-W         | DIRE    | CTI   | ON.      | 70 1          | MILES       | IN   | 1 N-S      | DIRECTION   |
| 42. POINTING ACCURACY 43. POINTING RATE                  |             | 44. ALT | TUD   | E        |               | 45. INCL    | INA  | TION       |             |
| NA NA  |             | GEO/    | SYN   | СН       |               | 0.          |      | D          | EG          |
| 46. SPECIAL REQUIREMENTS                                 |             |         |       |          |               |             |      |            |             |
| NONE   |             |         |       |          |               |             |      |            |             |
| 47. COMPONENTS   |             |         |       | _        |               |             |      | -A         |             |
| TRANSMITTERS, RECEIVER                                   | SAN         | ) ASS   | JUI   | ATED     | EL            | ECTRO       | III  | 7.5        |             |
| 48. WEIGHT 49. VOLUME                                    | l .         |         |       | 1. STAND | BY PO         | VER 52. F   | PEA  | C POWER    | 53. MTBF    |
| 10 LB 1. CU FT   | <b>_</b>    | TAW     |       |          |               |             |      |            | 1 YEAR      |
| 54. INTERFERENCE 55. MAGNETIC 56. INTERFERENCE 56. INTER |             | 57. INT |       |          | <b>58</b> . 9 | HIELDIN     | G    |            |             |
|  | <u>NE</u>   | SEI     | NSI   | TIVE     |               |             |      |            |             |
| 59. CALIBRATION  |             | ATA REC |       | RY       |               |             |      |            | BSERVATION  |
| ON GROUND  | RE          | ALTIM   | E     |          |               |             | 16   | 5 MIN      | PER DAY     |
| 62. TELEMETRY REQUIREMENTS                               | <del></del> |         |       |          |               |             |      |            |             |
| 10 DIGITAL, 12 ANALOG C                                  | HANNE       | ELS     |       |          |               |             |      |            |             |
|  |             |         |       |          |               |             |      |            |             |
|  |             |         |       |          |               |             |      |            |             |
| 63. ADVANTAGES AND LIMITATIONS                           |             |         |       |          |               |             |      |            |             |
|  |             |         |       |          |               |             |      |            |             |
|  |             |         |       |          |               |             | **** |            |             |
| 64. REFERENCES   |             |         |       |          |               |             |      |            |             |
| 1) RADIO FREQUENCY INTE                                  |             |         |       |          |               |             |      |            |             |
| FOR THE APPLICATION TEC                                  |             |         |       |          |               |             |      |            |             |
| JOHN J. KELLEHER, NASA                                   |             |         |       |          |               |             |      |            |             |
| PORT FOR RADIO-FREQUENC                                  |             |         |       |          |               | KIMEN       | ,    | CONTR      | ACT NASS-   |
| 2150A. HUGHES AIRCRAFT                                   | CU.,        | AUGU    | 51,   | 197      | 0.            |             |      |            |             |
| 65. HISTORICAL REMARKS                                   |             |         |       | -        |               |             |      |            |             |
| 65. HISTORICAL NEWARKS                                   |             |         |       |          |               | <del></del> |      |            |             |
|  |             |         |       |          |               |             |      |            | <del></del> |
|  |             |         |       |          |               |             |      |            |             |
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### INSTRUMENT RESUME

### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771

| 1. TITLE             |                   |        |                    |         |                   |       | 2. /               | ACRONYM    | 3.  | EXP NO          |
|----------------------|-------------------|--------|--------------------|---------|-------------------|-------|--------------------|------------|-----|-----------------|
| SATELLITE            | RANGE AND R       | ANGE   | E-RATE EXPERI      | MEN     | T                 |       | GP                 | ΔPR        |     |                 |
| (TITLE CONT.         | ) .               |        |                    |         |                   |       | 4. R               | ESUME DATE |     | 5.<br>VERSION   |
|                      |                   |        |                    |         |                   |       | 0.9                | /01/7      | 2   | 2004            |
| 6. PRINCIPAL II      | NVESTIGATOR       | 7. OR  | GANIZATION         |         |                   | 8. T  | ELEPHO             | NE         |     |                 |
| BERBERT,             | J.H.              | GODE   | DARD SPACE FL      | TC      | ENTER             | 301   | <del>-</del> 982   | -5042      |     |                 |
| 9. CO-INVESTIG       |                   | 10. OR | GANIZATION         |         |                   | 11. T | ELEPHO             | NE         |     |                 |
|                      |                   |        | ,                  |         |                   |       |                    |            |     |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. FLASH INDEX NU | MBER    | 15. START<br>DATE | 16. C | OMPLETION<br>DATE  | 17. STA1   | rus |                 |
|                      |                   |        |                    |         |                   |       |                    | OPERA      | TI  | ONAL            |
| 18. MONITOR          |                   | 19. AG | ENCY               | 20. PGA | OFFICE            | 21. T | ELEPHO             | ONE        |     |                 |
| ROSENBERO            | G, J.D.           | NASA   | A HDQTRS           | OA/     | ECD               | 202   | 755                | -2322      | 2   |                 |
| 22. VENDOR           |                   |        | 23. LOCATION       |         |                   |       | 24. FLIGHT<br>DATE | 25. L      | EAC | TIME            |
| GODDARD S            | SPACE FLT CEN     | ITER   | GREENBELT, M       | 1D •    |                   |       | 01/6               | 8 NA       |     |                 |
| 26. INSTRUMEN        | T TYPE            |        |                    |         |                   |       |                    |            |     | 27.<br>SECURITY |
| TRANSPONE            | DER, S-BAND 2     | 271    | MHZ (RECEIVE       | ) A     | ND 170            | )5 M  | 1HZ (              | XMIT)      |     | UNC             |
| 28. APPLICATIO       | N                 |        |                    |         | 29. SPACE         | CRAF  | T                  |            |     |                 |
| GEOD                 |                   |        |                    |         | GEOS 2            | 2     |                    |            |     |                 |
| 20 DIIDDOCE          |                   |        |                    |         |                   |       |                    |            |     |                 |

30. PURPOSE

PRIMARY-TO BE USED FOR TRACKING THE SATELLITE TO AUGMENT GEO-DETIC DATA.\*\*\*SECONDARY-TO PROVIDE A COMPARISON OF THIS SYSTEM AND THE OTHER GEODETIC MEASUREMENT INSTRUMENTS ON BOARD.

#### 31. PRINCIPLES OF OPERATION

THIS SYSTEM PROVIDES MEASUREMENT OF SLANT RANGE AND THE RATE OF CHANGE OF SLANT RANGE OF THE SPACECRAFT. THE RANGE IS OBTAINED BY MEASURING THE PHASE SHIFT OF A WAVE TRAVELLING FROM THE GROUND TRANSMITTER TO THE SATELLITE AND BACK. RANGE RATE IS MEASURED BY DETERMINING THE DOPPLER-SHIFT EFFECT ON SEVERAL MOD-ULATION FREQUENCIES. THE TRANSPONDER RECEIVES SIMULTANEOUS SIG-NALS FROM ONE TO THREE GROUND STATIONS AT 2271 MHZ, MODULATED BY THE RANGING SIDETONES. THE TRANSPONDER TRANSLATES THESE SIGNALS INTO THE LOWER CARRIER FREQUENCY (1705 MHZ), WHILE PRESERVING THE COHERENCE OF THE RANGE TONE MODULATION. THE COHERENCE IS PRESERVED BY USING THE SAME OFFSET OSCILLATOR AS A SOURCE FOR THE BASIC FREQUENCY FOR THE DOWN-CARRIER. AND AS A HETERODYNE SOURCE FOR THE UP-CARRIER. NO DEMODULATION OF THE RANGING TONES TAKES PLACE WITH THE UP-CARRIER. THE POWER SUPPLY UNIT IS SHARED WITH THE SECOR AND C-BAND TRANSPONDERS.

#### 32. PHENOMENA OBSERVED

<u> 2271 MHZ (S-BAND) RADIO TRANSMISSIONS FROM GROUND STATIONS</u>

#### 33. MEASUREMENT RANGE

NA

34. PRECISION AND ACCURACY

ACCURACY OF RANGE MEASUREMENT IS APPROXIMATELY 10 METERS

| 35. SPECTRAL RANGE                     | · · · · · · · · · · · · · · · · · · · | 36. SPECTRAL RE    | SOLUTION    | 37. TIME CONSTANT     |
|--|---------------------------------------|--------------------|-------------|-----------------------|
| SEE ITEM 31                            |                                       | NA                 |             |                       |
| 38. FIELD OF VIEW                      | 39. GROUND SWA                        | <u> </u>           |             | •                     |
|  |                                       |                    |             |                       |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES | OLUTION                               |                    |             |                       |
| NA                                     |                                       |                    |             |                       |
| 42. POINTING ACCURACY 43. POINTING RAT | E 44. ALT                             | ITUDE              | 45. INCLINA |                       |
| NA NA                                  | MED                                   | ECCENTRIC          | HIGH        | RETROGRADE            |
| 46. SPECIAL REQUIREMENTS               |                                       |                    |             |                       |
|  | w                                     |                    | <del></del> |                       |
| 47. COMPONENTS                         |                                       |                    |             |                       |
| TRANSPONDER                            |                                       |                    | T 50 D5 A   | K DOWED TEN MEDE      |
| 48. WEIGHT 49. VOLUME                  | 50. AVERAGE POW                       | ER 51. STANDBY POV |             | K POWER   53. MTBF    |
| 8 LB                                   | NUCLEAR 57. INT                       |                    | HIELDING    | MATIS                 |
| SOURC/SEN                              | ERFERENCE "INT                        | ERFERENCE 30. 3    | MIECDING    |                       |
| 59. CALIBRATION                        | 60. DATA RE                           | COVERY             | 61. FRE     | QUENCY OF OBSERVATION |
| NONE                                   |                                       | E TELEMETRY        |             | MIN PER DAY           |
| 62. TELEMETRY REQUIREMENTS             | JACAC 1111                            | _ 166676           | 1.0.4.1     |                       |
| SEE ITEM 31                            |                                       |                    |             |                       |
|  |                                       |                    |             |                       |
|  |                                       |                    |             |                       |
| 63. ADVANTAGES AND LIMITATIONS         |                                       |                    |             |                       |
| RANGE SIGNAL MARGIN (2                 | 7 DB AT 90                            | O NM SLANT         | RANGE)      | IS SLIGHTLY           |
| LOWER THAN SECOR.                      |                                       |                    |             |                       |
| 64. REFERENCES                         |                                       |                    |             |                       |
| 1) NASA PRESS KIT FOR G                |                                       |                    |             |                       |
| PARAMETRIC ANALYSIS FOR                |                                       |                    |             |                       |
| COMMUNICATIONS AND SYS                 |                                       |                    |             |                       |
| ***3) PLANNED OPERATION:               |                                       |                    |             |                       |
| TIONS AND SYSTEMS, INC                 | , KEPUKI N                            | J. K-4035-4        | 15-2, U     | L1 1967.              |
| 65. HISTORICAL REMARKS                 |                                       |                    |             |                       |
| ALSO FLOWN ON GEOS 1.                  | CEUS 2 IS                             | ALSO KNOWN         | AS EYDI     | INDED 36              |
| ALSO FEUNN ON GEOS I.                  | <u> </u>                              | ACSU KNOWN         | AJ LAFT     | LUNEN JU              |
|  |                                       |                    |             |                       |
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#### INSTRUMENT RESUME

### NATIONAL AERONAU (ICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER

|                      |                  |        | GREENBELI, MD.     | 20//1 |                   |                  |                   |            | _   |                 |
|----------------------|------------------|--------|--------------------|-------|-------------------|------------------|-------------------|------------|-----|-----------------|
| 1. TITLE             |                  |        |                    |       |                   |                  | 2. /              | ACRONYM    | 3.  | EXP NO          |
| SEQUENTIA            | AL COLLATION     | OF I   | RANGE SYSTEM       |       |                   |                  | SE                | COR        |     |                 |
| (TITLE CONT.         |                  |        |                    |       |                   |                  | 4. R              | ESUME DATE |     | 5.<br>VERSION   |
|                      |                  |        |                    |       |                   |                  | 09                | /01/7      | 2   | 2004            |
| 6. PRINCIPAL II      | NVESTIGATOR      | 7. OR  | GANIZATION         |       |                   | 8. T             | ELEPHO            | NE         |     |                 |
| MCCALL.              | J <b>.</b>       |        |                    |       |                   | }                |                   |            |     |                 |
| 9. CO-INVESTIG       | SATOR            | 10. OR | GANIZATION         |       |                   | 11. T            | ELEPHO            | NE         |     |                 |
|                      |                  |        |                    |       |                   |                  |                   |            |     |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUM | BER    | 14. FLASH INDEX NU | JMBER | 15. START<br>DATE | 16. <sup>C</sup> | OMPLETION<br>DATE | 17. STAT   | 'US |                 |
|                      |                  |        |                    |       |                   |                  |                   | OPERA      | TI  | ONAL            |
| 18. MONITOR          |                  | 19. AG | 19. AGENCY         |       | 20. PGM OFFICE    |                  | 21. TELEPHONE     |            |     |                 |
| ROSENBERO            | G, J.D.          | NAS    | A HDQTRS           | OA/   | ECD               | CD 202-          |                   | -2322      |     |                 |
| 22. VENDOR           |                  |        | 23. LOCATION       |       |                   |                  | 24. FLIGH<br>DATE | 25. L      | EAC | TIME            |
| CUBIC CO             | RPORATION        |        | SAN DIEGO.         | CAL   |                   |                  | 01/6              | 8 NA       |     |                 |
| 26. INSTRUMEN        | IT TYPE          |        |                    |       |                   |                  |                   |            |     | 27.<br>SECURITY |
| TRANSPON             | DER, RANGING     |        |                    |       |                   |                  |                   |            |     | UNC             |
| 28. APPLICATIO       | N                |        |                    |       | 29. SPACE         | CRAF             | T                 |            |     |                 |
| GEOD                 |                  |        |                    |       | GEOS :            | 2                |                   |            |     |                 |
| 30. PURPOSE          |                  |        |                    |       |                   |                  |                   |            |     | -               |

PRIMARY-TO DETERMINE POSITIONS BY GEOMETRIC MEANS IN A STEP BY STEP FASHION, AND TO EXTEND A GEOMETRIC SURVEY AROUND THE EARTH.

#### 31. PRINCIPLES OF OPERATION

THE RANGE TRANSPONDER FLOWN ON GEOS 1. AS WELL AS GEOS 2. IS USED IN CONJUNCTION WITH THE ARMY SECOR (SEQUENTIAL COLLATION OF FOUR GROUND STATIONS INTERROGATE THE SATELLITE RANGE) SYSTEM. IN TURN FOR RANGING TO THE SPACECRAFT TRANSPONDER. PANGE MEA-SUREMENTS ARE MADE BY MEASURING THE PHASE SHIFT OF THE RANGING SIDETONES WHICH MODULATE THE CW CARRIER. BY USING GEOMETRIC TECHNIQUES THE UNKNOWN POSITION OF 1 OF 4 STATIONS CAN BE AC-CURATELY DETERMINED. A SEQUENCE OF 4 INTERROGATIONS, 1 FROM EACH STATION, IS ACCOMPLISHED IN 50 MILLESEC; THESE SEQUENCES CAN BE REPEATED AT A RATE OF 20 A SECOND. IN OPERATION, THE TRANSPONDER RECEIVES AN INTERROGATING SIGNAL (421 MHZ), REMOVES THE FM RANGING FREQUENCIES FROM THE CARRIER AND LOCALLY GENER-ATES TWO COHERENT REPLY CARRIERS, MODULATING ONE (449 MHZ) WITH ALL THE FM RANGING FREQUENCIES AND THE OTHER (224.5 MHZ) WITH ONLY THE 585.533 KHZ RANGING FREQUENCY. THE SECOND CARRIER ALLOWS A CORRECTION TO BE MADE FOR IONOSPHERIC REFRACTION EF-THE SECOR TRANSPONDER IS OPERATED FROM A POWER SUPPLY IT SHARES WITH THE SRARR AND C-BAND TRANSPONDERS.

#### 32. PHENOMENA OBSERVED

RE TRANSMISSION FROM GROUND STATIONS AT 421 MHZ

#### 33. MEASUREMENT RANGE

#### 34. PRECISION AND ACCURACY

LACCURACY OF RANGE MEASUREMENT IS APPROXIMATELY 10 METERS

| 35. SPECTRAL RANGE             |  |                                       |                                     | 36.                 | SPECTRA                               | AL RE        | SOLUTION   | 37. TIME  | CONSTANT    |
|--------------------------------|--|---------------------------------------|-------------------------------------|---------------------|---------------------------------------|--------------|------------|-----------|-------------|
| SEE ITEM 31                    | A STATE OF THE STA |                                       |                                     | I NA                | ٩                                     |              |            |           |             |
| 38. FIELD OF VIEW              |  | 39. GRO                               | UND SWA                             |                     |                                       |              | 10877      |           |             |
| NA                             |  |                                       |                                     |                     |                                       |              |            |           |             |
| 40. ANGULAR RESOLUTION         | 41. SPATIAL RE   | SOLUTION                              |                                     |                     |                                       |              |            |           |             |
| NA                             | NA   |                                       |                                     |                     |                                       |              |            |           |             |
| 42. POINTING ACCURACY          | 43. POINTING RA  | re                                    | 44. ALT                             | ITUE                | DE                                    |              | 45. INCLIN | ATION     |             |
| NA                             | NA   | an and a second                       | MED                                 | EC                  | CENT                                  | 11S          | HIGH       | R         | ETROGRADE   |
| 46. SPECIAL REQUIRE            | MENTS  |                                       |                                     |                     |                                       |              |            |           |             |
|                                |  | WART ALLE                             |                                     |                     |                                       |              |            |           |             |
| 47. COMPONENTS                 |  | · · · · · · · · · · · · · · · · · · · |                                     |                     |                                       |              |            |           | <u> </u>    |
| TRANSPONDER  48. WEIGHT 49. VO | DLUME  | I EO AVE                              | RAGE POW                            | 1                   | E1 STAND                              | DV DOM       | ER 52. PE  | K POWER   | 53. MTBF    |
| 11 LB                          | JEONE  | 30. AVE                               | HAGE FOIL                           | En_                 |                                       | . meant book |            |           |             |
|                                | MAGNETIC 56. IN  | NUCLEAR<br>TERFERENCE                 | 57. INT                             | HERMA               |                                       | WAT 1        | HIELDING   | WATTS     |             |
| SOURC/SEN                      | inference  | TENTENENCE                            | -                                   | en en               | LINCE                                 |              |            |           |             |
| 59. CALIBRATION                |  | 60. C                                 | ATA REC                             | COVE                | ERY                                   | <b>!</b>     | 61. FR     | QUENCY OF | OBSERVATION |
| NONE                           | at   |                                       | ALTIM                               | and the same of the |                                       | FTRY         | / 30       | MINUTE    | S PER DAY   |
| 62. TELEMETRY REQ              | UIREMENTS  | -                                     | · · · · · · · · · · · · · · · · · · |                     | · · · · · · · · · · · · · · · · · · · |              |            |           |             |
| SEE ITEM 31                    |  |                                       |                                     |                     |                                       |              |            |           |             |
|                                | ,  |                                       |                                     |                     |                                       |              |            |           |             |
|                                |  | VIII.                                 |                                     |                     |                                       |              |            |           |             |
| 63. ADVANTAGES AN              |  | i                                     | 8                                   |                     |                                       |              |            |           |             |
| LOCATION ERR                   | DRS ARE AD   | DITIV                                 | E AS                                | GRC                 | OUND S                                | STAT         | M SUCI     | OVE.      |             |
| 64. REFERENCES                 | H  |                                       |                                     | 1 1 2               |                                       | • 7          |            |           |             |
| 1)NASA PRESS                   | KIT FOR G  | EOS-B                                 | REL                                 | EAS                 | E NO                                  | 68           | 3-2K. J    | AN 7.     | 68.***21    |
| PARAMETRIC A                   |  |                                       |                                     |                     |                                       |              |            |           |             |
| COMMUNICATIO                   | NS AND SYS   | TEMS.                                 | INC,                                | RE                  | PORT                                  | NO.          | R-403      | 5-50-2    | , JAN 68.   |
| ***3)PLAN OF                   |  |                                       |                                     |                     |                                       |              |            |           |             |
| TIONS AND SY                   | STEMS, INC   | , REPO                                | ORT NO                              | Э.                  | R-403                                 | 35-4         | 5-2, 0     | CT 196    | 7.          |
| 65. HISTORICAL REM             | ARKS   |                                       |                                     |                     |                                       |              |            |           |             |
| GEOS 2 IS AL                   |  | C EYDI                                | OPED                                | 2.6                 |                                       |              |            |           |             |
| OCOS Z IS AL                   | JO KNOWN A   | S LAFI                                | UNLK                                | <u> </u>            | <del>! •</del>                        |              |            |           |             |
|                                |  |                                       |                                     |                     |                                       |              |            |           |             |
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| 1                              |  |                                       |                                     | •                   | •                                     |              |            |           |             |
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|   |             | ARD SPACE    |                   |                                       | ITER                 | ,                                      |                   |                      |             |                 |
|---|-------------|--------------|-------------------|---------------------------------------|----------------------|--|-------------------|----------------------|-------------|-----------------|
| 1. TITLE                                | <u>'</u>    | ONLLINDELI   | , 1410. 2         |                                       |                      | ······································ | 2                 | ACRONYM              | 3. F        | XP NO           |
| ATS/F/NIMBUS-E TRACKI                   | ING A       | ND DATA      | RFIA              | Y F                                   | XPER 1               | MENI                                   |                   | )RE                  | <del></del> |                 |
| (TITLE CONT.)                           | 110 4       | HILL DATA    | 19 <u>L. L. A</u> | 1 1                                   | <u>ega (m. 15. 1</u> |  |                   | RESUME DATE          | $\top$      | 5.<br>VERSION   |
|   |             |              |                   | · · · · · · · · · · · · · · · · · · · |                      |  |                   | 9/01/7               |             | 0002            |
| 6. PRINCIPAL INVESTIGATOR               | 7. OR       | GANIZATION   |                   |                                       |                      | 8. T                                   | ELEPHO            |                      | <u>- 1</u>  | <u> </u>        |
| PICKARD, R.H.                           | GDDD        | ARD SPA      | CE FI             | T C                                   | ENTER                | 301                                    | -982              | 2-5042               |             |                 |
| 9. CO-INVESTIGATOR                      | <del></del> | GANIZATION   | <u></u>           |                                       | <b>-</b>             |  | ELEPH             |                      |             |                 |
| HEFFERNAN. P.J.                         | GODE        | ARD SPA      | CE FL             | TC                                    |                      |  |                   | 2-5042               |             |                 |
| 12. CONTRACT 13. CONTRACT NUMB          |             | 14. FLASH IN |                   |                                       | 15. START            |  |                   | 17. STAT             |             |                 |
| NA NA                                   |             |              |                   |                                       |                      | I                                      |                   |                      |             |                 |
| 18. MONITOR                             | 19. AG      | ENCY         |                   | 20. PGN                               | OFFICE               | 21. 1                                  | ELEPH             | ONE                  |             |                 |
| BURKE, J.R.                             | NASA        | HDQTRS       |                   | OA/                                   | EÇ S                 | 202                                    | 75                | 5-2322               |             |                 |
| 22. VENDOR                              |             | 23. LOCATIO  | N                 |                                       |                      |  | 24. FLIGH<br>DATE | 1 <sup>†</sup> 25. L | EAD         | TIME            |
| NA                                      |             | N            | Α                 |                                       |                      |  |                   |                      |             |                 |
| 26. INSTRUMENT TYPE                     |             |              |                   |                                       |                      |  |                   |                      |             | 27.<br>SECURITY |
| TRANSPONDER, RECEIVER                   | AND         | DECODE       | P, TE             | LEM                                   | ETRY                 | TRAN                                   | ISMI              | TER                  |             | UNC             |
| 28. APPLICATION                         |             |              |                   |                                       | 29. SPAC             |  |                   |                      |             |                 |
| COMM, SATELLITE TRACK                   | KING        |              |                   |                                       | ATS-F                | AND                                    | NI                | 4BUS-E               |             |                 |
| 30. PURPOSE                             |             |              |                   |                                       |                      |  |                   |                      |             |                 |
| PRIMARY-TO DEVELOP TI                   | ECHNO       | LOGY LE      | ADING             | TO                                    | AN C                 | PERA                                   | IOITA             | VAL SY               | 'ST         | EM              |
| OF TRACKING AND DATA                    | RELA        | Y SATEL      | LITES             | (T                                    | DRS)                 | BY F                                   | PROV              | IDING                | DA          | TΑ              |
| ON PERFORMANCE OF THE                   | E REA       | L-TIME       | COMMA             | ND                                    | AND 1                | TELEN                                  | 1ETR'             | Y RELA               | ١Y          | AND             |
| LONG-ARC RANGE AND RA                   | ANGE-       | -RATE TR     | ACKIN             | IG O                                  | FAL                  | _OW A                                  | LTI               | TUDE S               | TA          | EL-             |
| LITE***SECONDARY-TO                     | DETER       | RMINE NI     | MBUS-             | •E 0                                  | RBIT                 | TO I                                   | HTIN              | IN 50                | ME          | TEPS            |
| IN A TOTAL ELAPSED T                    | IME C       | F SEVER      | AL HO             | UR S                                  | •                    |  |                   |                      |             |                 |
| 31. PRINCIPLES OF OPERATION             |             |              |                   |                                       |                      |  |                   |                      |             |                 |
| A RANGE AND RANGE RAT                   | re si       | IGNAL US     | ING 1             | LOOK                                  | HZ AS                | S THE                                  | HI                | GHEST                | TR          | ACK-            |
| ING TONE IS GENERATED                   | D BY        | PHASE M      | ODULA             | TIO                                   | N OF                 | A 70                                   | HM C              | Z CARF               | ₹IE         | R               |
| ALL SIDE TONES, THE                     |             |              |                   |                                       |                      |  |                   |                      |             |                 |
| CIES ARE SYNTHESIZED                    |             |              |                   |                                       |                      |  |                   |                      |             |                 |
| THE TRACKING SIGNAL                     |             |              |                   |                                       |                      |  |                   |                      |             |                 |
| THE SIGNAL IS RECEIVE                   |             |              |                   |                                       |                      |  | -                 | _                    | _           |                 |
| 1 · · · · · · · · · · · · · · · · · · · |             | RELAYED      |                   |                                       |                      |  |                   |                      | _           |                 |
| BACK TO ATS-F FOR COL                   |             |              |                   |                                       |                      |  |                   |                      |             | ON              |
| RECEPTION AT THE ATS                    |             |              | •                 |                                       |                      |  |                   |                      |             | _               |
| RANGE-RATE MEASUREMEN                   |             |              |                   |                                       |                      |  |                   |                      |             |                 |
| (WITH TIME TAGS) ARE                    |             |              |                   |                                       |                      |  |                   |                      |             |                 |
| SHIPMENT TO THE GSFC                    |             |              |                   |                                       |                      |  |                   |                      |             |                 |
| ESTABLISH ATS-F AS A                    |             |              |                   |                                       |                      |  |                   | -                    |             |                 |
| ACQUISTION AND RANGE                    |             |              |                   |                                       |                      |  |                   |                      |             |                 |
| TORIAL SYNCHRONOUS DE                   |             |              |                   |                                       |                      |  |                   |                      |             |                 |
| REFLECTER WILL BE PRO                   |             |              |                   |                                       |                      |  |                   |                      |             |                 |
| AS THE LATTER MOVES                     |             |              |                   |                                       |                      |  |                   |                      |             |                 |
| NIMBUS-E WILL CARRY                     |             |              |                   |                                       |                      |  |                   |                      |             |                 |
| STEERABLE ANTENNA TO                    |             |              |                   |                                       |                      |  |                   |                      |             |                 |
| GATION LOSSES ENCOUN                    | I ERE       | D IN A I     | PACK.             | LNG_                                  | AND                  | DATA                                   | REL               | AY GE                | JME         | TRY.            |
| 32. PHENOMENA OBSERVED                  | <u> </u>    |              |                   |                                       |                      |  |                   |                      |             |                 |
| C-BAND AND S-BAND RA                    | 010         | SIGNALS      |                   |                                       |                      |  |                   |                      |             |                 |
| 33. MEASUREMENT RANGE                   |             |              |                   |                                       |                      |  |                   |                      |             |                 |
| NA                                      |             |              |                   |                                       |                      |  |                   |                      |             |                 |
| 34. PRECISION AND ACCURACY              |             |              |                   | =                                     |                      |  |                   |                      |             |                 |
| 50 METERS IN SEVERAL                    | <u> </u>    | RS ELAPS     | ED TE             | RACK                                  | ING                  | TIME                                   |                   |                      |             |                 |

| 35. SPECTRAL      | RAN   | GE                       |             | -                |              | 36    | SPECTRA      | AL RE  | SOLU  | TION    | 37. TIME | CONSTANT   |
|-------------------|-------|--------------------------|-------------|------------------|--------------|-------|--------------|--------|-------|---------|----------|--|
| NΔ                |       |                          |             |                  |              | T     | NA           |        |       |         | N.       |  |
| 38. FIELD OF V    | IEW   |                          | ]:          | 39. GRO          | UND SW       | ATH   |              |        |       |         |          |  |
| NA                |       |                          |             |                  | NA           |       |              |        |       |         |          |  |
| 40. ANGULAR RESC  | OLUT  | ION 41. SPATIAL          | RESO        | LUTION           |              |       |              |        |       |         | -        |  |
|                   |       |                          |             |                  |              |       | ***          |        |       |         |          |  |
| 42. POINTING ACCU | JRAC  | 43. POINTING             | RATE        |                  | 44. ALT      |       |              |        |       | NCLINA  |          | VOICE CONTRACT                                   |
|                   |       |                          |             |                  | SYNC         | Н     | LIKCU        | LAK    | ΕŲ    | UATU    | KIAL P   | POSIGRADE  |
| 46. SPECIAL RE    | :QUI  | REMENTS                  |             |                  | _            |       |              |        |       |         |          |  |
| 47. COMPONEN      | TC    | <del> </del>             | <del></del> |                  |              |       |              |        |       |         |          |  |
| TRANSPON          |       | ₹.                       |             |                  |              | _     |              |        |       |         |          |  |
| 48. WEIGHT        | T-    | VOLUME                   |             | 50. AVE          | RAGE POW     | ÆR    | 51. STAND    | BY POW | /ER   | 52. PEA | K POWER  | 53. MTBF   |
|                   |       |                          | <del></del> | t                | <del></del>  |       | <del> </del> |        | -     |         |          | <del>                                     </del> |
| 54. INTERFERENCE  | 55.   | MAGNETIC<br>INTERFERENCE | 56. NUC     | CLEAR<br>FERENCE | 57. IN1      | THERM | AL<br>RENCE  | 58. S  | HIEL  | DING    |          |  |
| SOURCE/S          | EΝ    | NONE                     | NO          | NE               |              |       |              |        |       |         |          |  |
| 59. CALIBRATIO    | ON    |                          |             |                  | ATA RE       |       |              |        |       |         |          | OBSERVATION                                      |
| NONE              | ·     |                          | <u> </u>    | R                | EALTI        | ME    | TELE         | MET    | ₹Y    | ON      | COMMA    | ND   |
| 62. TELEMETRY     |       |                          | <u> </u>    | <b>T</b> 5 *     | <del>+</del> |       | <u> </u>     |        | ~ ~   |         | 10 10    | V 0 0 C  |
|                   |       | RANSMITT                 |             |                  |              |       |              |        |       |         | NU 400   | F KBP5.  |
| NIWRO2-F          | U     | ATA TRANS                | MITI        | EU V             | IA AI        | >-    | r al         | + K!   | 5 Y S | •       |          |  |
| 63. ADVANTAG      | SES A | ND LIMITATIO             | NS          |                  |              |       |              |        |       |         |          |  |
|                   |       | DE FAST H                |             | Y AC             | CURAT        | F     | TRACK        | ING    | IN    | FORM.   | ATION.   | <u> </u>   |
|                   |       |                          |             |                  |              | -     |              |        | _     |         |          |  |
| 64. REFERENCE     | ES    |                          | 1           |                  |              |       |              |        |       |         |          |  |
|                   |       | •                        |             |                  |              |       |              |        |       |         |          | S-E TRACK-                                       |
| ING AND           | DA1   | TA RELAY                 | EXPE        | RIME             | NT, G        | SF    | C PUB        | LIC    | TTA   | 0N.     | OCTOBE   | R, 1970.   |
|                   |       |                          |             |                  |              |       |              |        |       |         |          |  |
| 1                 |       |                          |             |                  |              |       |              |        |       |         |          |  |
|                   |       |                          |             |                  |              |       |              |        |       |         |          |  |
| 65. HISTORICA     | ı BE  | MARKS                    |             |                  |              |       |              |        |       |         |          |  |
| O. HISTORICA      | - 110 | MANKS                    |             |                  |              |       |              |        |       | ···-    |          |  |
| <del> </del>      |       |                          |             |                  |              |       |              |        |       |         |          |  |
|                   |       |                          |             |                  |              |       |              |        |       |         |          |  |
|                   |       |                          |             |                  |              |       |              |        |       |         |          |  |
| ľ                 |       |                          |             |                  |              |       |              |        |       |         |          |  |
|                   |       |                          |             |                  |              |       |              |        |       |         |          |  |
| ]                 |       |                          |             |                  |              |       |              |        |       |         |          |  |
|                   |       |                          |             |                  |              |       |              |        |       |         |          |  |
| in .              |       |                          |             |                  |              |       |              |        |       |         |          |  |
| İ                 |       |                          |             |                  |              |       |              |        |       |         |          |  |
|                   |       |                          |             |                  |              |       |              |        |       |         |          |  |
| ł                 |       |                          |             |                  |              |       |              |        |       |         |          |  |
|                   |       |                          |             |                  |              |       |              |        |       |         |          |  |
|                   |       |                          |             |                  |              |       |              |        |       |         |          |  |
|                   |       |                          |             |                  |              |       |              |        |       |         |          |  |
|                   |       |                          |             |                  |              |       |              |        |       |         |          |  |
| 1                 |       |                          |             |                  |              |       |              |        |       |         |          |  |
| [                 |       |                          |             |                  |              |       |              |        |       |         |          |  |
|                   |       |                          |             |                  |              |       |              |        |       |         |          |  |
|                   |       |                          |             |                  |              |       |              |        |       |         |          |  |
| 1                 |       |                          |             |                  |              |       |              |        |       |         |          |  |

|                             | GODI        | GREENBELT,    |           | IEK               |   |                |                                       |
|-----------------------------|-------------|---------------|-----------|-------------------|---|----------------|---------------------------------------|
| 1. TITLE                    |             |               |           |                   |   | 2. ACRONYM     | 3. EXP NO                             |
| NIMBUS-E/ATS-F TR           | ACKING /    | AND DATA      | RELAY EX  | PERIM             | ENT T                                   | DRE            |                                       |
| (TITLE CONT.)               |             |               |           |                   |   | 4. RESUME DATE | 5.<br>VERSION                         |
|                             |             |               |           |                   |   | 9/01/7         | 2 0002                                |
| 6. PRINCIPAL INVESTIGATOR   | 7. OR       | GANIZATION    |           |                   | 8. TELEPI                               | HONE           | <b>-</b>                              |
| PICKARD, R.H.               | GODI        | DARD SPACE    | E FLT CE  | NTFR              | 301-98                                  | 2-5042         |                                       |
| 9. CO-INVESTIGATOR          | 10. OR      | GANIZATION    |           |                   | 11. TELEP                               | HONE           |                                       |
| HEFFERNAN. P.J.             | GODE        | DARD SPAC     | E FLT CE  | NTER              |   | 32-5042        |                                       |
| 12. CONTRACT 13. CONTRACT   | <del></del> | 14. FLASH IND |           | 15. START<br>DATE |   | ON 17. STAT    |                                       |
| NA NA                       |             | <u> </u>      |           |                   |   |                | MODEL                                 |
| 18. MONITOR                 | 19. AG      | ENCY          | 20. PGM   | OFFICE            | 21. TELEP                               |                |                                       |
| BURKE, J.R                  | NASA        | HDOTES        | OA/E      | CS                |   | 5-2322         |                                       |
| 22. VENDOR                  |             | 23. LOCATION  |           |                   | 24. FLI                                 |                | EAD TIME                              |
| NA                          |             | NA            |           |                   | 12/                                     |                |                                       |
| 26. INSTRUMENT TYPE         |             |               |           |                   | 1                                       |                | 27.                                   |
| TRANSPONDER, RECE           | IVER AND    | DECODER       | • TELEME  | TRY T             | PANSMI                                  | TTER           | UNC                                   |
| 28. APPLICATION             |             |               |           | 9. SPACE          |   | . ,            | 10.10                                 |
| COMM, SATELLITE T           | RACKING     |               |           |                   |   | ATS-F          | 2001                                  |
| 30. PURPOSE                 |             |               |           |                   |   |                |                                       |
| PRIMARY-TO DEVELO           | P TECHNO    | DIOGY LEAD    | DING TO   | ΔΝ ΩΡ             | FRATIC                                  | INAL SY        | STEM                                  |
| OF TRACKING AND D           |             |               |           |                   |   |                |                                       |
| ON PERFORMANCE OF           |             |               |           |                   |   |                |                                       |
| LONG-ARC PANGE AN           |             |               |           |                   |   |                |                                       |
| LITE *** SECONDARY-         |             |               |           |                   |   |                |                                       |
| IN A TOTAL ELAPSE           |             |               |           |                   | O 741 11                                |                | mu rung                               |
| 31. PRINCIPLES OF OPERATION |             | 7. 3. V. N.A. |           |                   |   |                |                                       |
| A RANGE AND RANGE           | RATE S      | IGNAL USI     | VG 100KH  | ZAS               | THE HI                                  | GHEST          | TRACK-                                |
| ING TONE IS GENER           |             |               |           |                   |   |                |                                       |
| ALL SIDE TONES, T           |             |               |           |                   |   |                |                                       |
| CIES ARE SYNTHESI           |             |               |           |                   |   |                |                                       |
| THE TRACKING SIGN           |             |               |           |                   |   |                |                                       |
| THE SIGNAL IS REC           |             |               |           |                   |   |                |                                       |
| GHZ. THE SIGNAL             |             |               |           |                   |   |                |                                       |
| BACK TO ATS-F FOR           |             |               |           |                   |   |                | UPON                                  |
| RECEPTION AT THE            |             |               |           |                   |   |                |                                       |
| RANGE-RATE MEASUR           | EMENTS A    | ARE MADE.     | FINALL    | Y. TH             | E OBSE                                  | RVED D         | ΔΤΔ                                   |
| (WITH TIME TAGS)            | ARE PUNC    | CHED ON PA    | APER TAP  | E FOR             | TRANS                                   | MISSIO         | N DR                                  |
| SHIPMENT TO THE G           | SEC COMP    | PUTING CE     | VTER. T   | HE BA             | SIC CC                                  | NCEPT          | ts to                                 |
| ESTABLISH ATS-F A           |             |               |           |                   |   |                |                                       |
| ACQUISTION AND RA           | NGE AND     | RANGE-RA      | TE TRACK  | ING S             | TATION                                  | IN FO          | ΠΔ-                                   |
| TORIAL SYNCHRONOU           | S ORBIT     | THE 30-       | -FOOT DI  | AMETE             | R ATS-                                  | F PΔRΔ         | 11 108                                |
| REFLECTER WILL BE           | PROGRAM     | MMED FOR (    | PEN-I DO  | P POI             | NTING                                   | AT NIM         | BUS-F                                 |
| AS THE LATTER MOV           | ES ACROS    | S THE FAI     | RTH IN I  | TS 60             | O NM P                                  | OLAR O         | RRIT.                                 |
| NIMBUS-E WILL CAR           | RY A RAN    | IGE AND RA    | ANGE-RAT  | F TRA             | NSPONO                                  | IFR AND        | \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ |
| STEERABLE ANTENNA           | TO COME     | PENSATE FO    | R INCRE   | ASED              | FREE S                                  | PACE P         | ี<br>คดอก <del>-</del>                |
| GATION LOSSES ENC           | OUNTERF     | ) IN A TRA    | ACK ING A | ND DA             | TA REI                                  | AY GEO         | METRY                                 |
| 32. PHENOMENA OBSERVED      | <u> </u>    | - 111         |           | HU UM             | •                                       | .ni ULU        |                                       |
| C-BAND AND S-BAND           | RADIO S     | SIGNALS       |           |                   |   |                |                                       |
| 33. MEASUREMENT RANGE       |             |               |           |                   |   |                |                                       |
| NA                          |             |               | _         |                   | *************************************** |                |                                       |
| 34. PRECISION AND ACCURAC   |             |               |           |                   |   |                |                                       |
| 50 METERS IN SEVE           | RAL HOUF    | S ELAPSE      | TRACKI    | NG TI             | ME                                      |                |                                       |

| 35. SPECTRAL I    | RANGE      |                                       |          |                 |             | 36.        | SPECTRA                                      | AL RE  | SOLU  | TION    | 37. TIME      | CONS  | TANT                                    |
|-------------------|------------|---------------------------------------|----------|-----------------|-------------|------------|--|--------|-------|---------|---------------|---|---|
| NA                |            |                                       |          |                 |             |            | NA   |        | .,    |         | ŊΔ            |   |   |
| 38. FIELD OF V    | IEW        |                                       | 3        | 39. GRO         | UND SWA     | ATH        |  |        |       |         |               |   |   |
| NA                |            |                                       |          |                 | NA          |            |  |        |       |         |               |   |   |
| 40. ANGULAR RES   | DLUTION 41 | . SPATIAL                             | . RESOL  | LUTION          |             |            | <u>.                                    </u> |        |       |         |               |   |   |
|                   |            |                                       |          |                 |             |            |  |        |       |         |               |   |   |
| 42. POINTING ACCU | RACY 43. P | POINTING                              | RATE     |                 | 44. ALT     |            |  |        |       | NCLINA  |               |   |   |
| 40.005044.00      |            |                                       |          |                 | SYNC        | <u>H (</u> | IPCU   | LAR    | EQI   | UATO    | RIAL P        | <u>'051</u>                                   | GRADE                                   |
| 46. SPECIAL RE    | QUIREME    | NTS                                   |          |                 |             |            |  |        |       |         |               |   | <u> </u>                                |
| 47. COMPONEN      | TO         |                                       |          |                 | <del></del> |            |  |        |       |         |               | <del></del>                                   |   |
| TRANSPON          |            | <del></del>                           |          |                 |             |            |  |        |       |         |               |   | <del></del>                             |
| 48. WEIGHT        | 49. VOLU   | ME                                    |          | 50 AVE          | RAGE POW    | FR         | 51. STAND                                    | BY POV | VER ! | 52. PEA | K POWER       | 53.   | MTBF                                    |
| 10.0021011        | -3. VOES   |                                       |          | -               |             |            |  | -      | -     |         |               | 1   |   |
| 54. INTERFERENCE  | 55. MAGNE  | TIC                                   | 56. NUC  | LEAR<br>FERENCE | 57. INT     | THERMA     | AL<br>ENCE                                   | 58. 9  | HIEL  | DING    |               | <u>,                                     </u> | ·····                                   |
| SOURCE/S          |            |                                       | NO       |                 |             |            |  |        |       |         |               |   |   |
| 59. CALIBRATIO    |            | <u> </u>                              | 1        |                 | ATA REC     | OVE        | RY   |        |       | 61. FRE | QUENCY OF     | OBSER   | VATION                                  |
| NONE              | •          |                                       |          | R               | EALTI       | MF         | TELE   | METE   | RΥ    | ON      | COMMA         | ND  |   |
| 62. TELEMETR      | REQUIRE    | MENTS                                 |          |                 |             |            |  |        |       |         |               |   |   |
| TEST DAT          | A TRAN     | SMITT                                 | ED A     | T RA            | res D       | F          | 50, 10                                       | 00,    | 200   | ) , AI  | ND 400        | KB  | PS.                                     |
| NIMBUS-E          |            |                                       |          |                 |             |            |  |        |       |         |               |   |   |
| 63. ADVANTAG      | ES AND LI  | MITATIO                               | NS       |                 |             |            |  |        |       |         |               |   |   |
| WILL PRO          | VIDE F     | AST H                                 | I GHL'   | Y ACC           | CURAT       | E T        | RACK   | ING    | INF   | ORMA    | ATION.        |   |   |
| 64. REFERENCI     |            | · · · · · · · · · · · · · · · · · · · | <u> </u> |                 |             |            |  |        |       |         |               |   | ·                                       |
| 1) PICKA          | RD. R.     | H. AI                                 | UD HI    | FFFF            | NAN.        | P          | .1.  | THE    | ΔΤ    | S-F/N   | ITMRIIS       | -F  | TRACK-                                  |
| ING AND           |            |                                       |          |                 |             |            |  |        |       |         |               |   |   |
|                   |            |                                       |          |                 | ,           |            |  |        |       |         |               |   | * |
|                   |            |                                       |          |                 |             |            |  |        |       |         |               |   |   |
|                   |            |                                       |          |                 |             |            |  |        |       | ,       |               |   |   |
|                   |            |                                       |          |                 |             |            |  |        |       |         |               |   |   |
| 65. HISTORICA     | L REMARK   | S                                     |          |                 |             |            |  |        |       |         |               |   |   |
|                   |            |                                       |          |                 |             |            |  |        |       |         | <del></del> . |   |   |
|                   |            |                                       |          |                 |             |            |  |        |       |         |               |   |   |
|                   |            |                                       |          |                 |             |            | ,  |        |       |         |               |   |   |
|                   |            |                                       |          |                 |             |            |  |        |       |         |               |   |   |
|                   |            |                                       |          |                 |             |            |  |        |       | -       |               |   |   |
|                   |            |                                       |          |                 |             |            |  |        |       |         |               |   |   |
|                   |            |                                       |          |                 |             |            |  |        |       |         | •             |   |   |
|                   |            |                                       |          |                 |             |            |  |        |       |         |               |   |   |
|                   |            |                                       |          |                 |             |            |  |        |       |         |               |   |   |
|                   |            |                                       |          |                 |             |            |  |        |       |         |               |   |   |
|                   |            |                                       |          |                 |             |            |  |        |       |         |               |   |   |
|                   |            |                                       |          |                 |             |            |  |        |       |         |               |   |   |
|                   |            |                                       |          |                 |             |            |  |        |       |         |               |   |   |
|                   |            |                                       |          |                 |             |            |  |        |       |         |               |   |   |
|                   |            |                                       |          |                 |             |            |  |        |       |         | •             |   | ŀ                                       |
|                   |            |                                       |          |                 |             |            |  |        |       |         |               |   | ļ                                       |
|                   |            |                                       |          |                 |             |            |  |        |       |         |               |   |   |
|                   |            |                                       | *:       |                 |             |            |  |        |       |         |               |   |   |
| ]                 |            |                                       |          |                 |             |            |  |        |       |         |               |   |   |
|                   |            |                                       | 4        |                 |             |            |  |        |       |         |               |   | İ                                       |
| J                 |            |                                       |          |                 |             |            |  |        |       |         |               |   |   |
| ı                 |            |                                       |          |                 |             |            |  |        |       |         |               |   | 1                                       |

### **INSTRUMENT RESUME** NATIONAL AFRONAUTICS AND SPACE ADMINISTRATION

|   | NATIONAL  | GODE   | ARD SPACE FL<br>GREENBELT, M   | IGHT CE                     | NTER  | 111/41                                       |   |   |  |   |   |
|---|---|--|--|-----------------------------|---|--|---|---|--|---|---|
| 1. TITLE  |   |  |  |                             |   |  | T   | 2. ACR  | ONYM   | 3. E  | EXP NO  |
|   | ON RELAY USI  | VG S   | MALL TERMI   | NALS                        |   |  |   | TPU   | S T  | NA  |   |
| (TITLE CONT.  |   | <u>,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,</u>   |  | <del></del>                 |   |  |   | 4 RESUM   | E DATE   |   | 5.<br>VERSION   |
| ****  |   |  |  |                             |   |  |   | 09/   | 01/7   |   | 0003  |
| 6. PRINCIPAL IN   | VESTIGATOR  | 7. OR  | GANIZATION   |                             |   | 8.   | TELEP   | HONE  |  |   |   |
| MILLER,   | . F.  | GODI   | DARD SPACE   | FLT                         | CENTE   | R 3  | 01-9  | 82-   | 5742   | 2   |   |
| 9. CO-INVESTIG  |   | 10. OR   | GANIZATION   |                             |   | 11.  | TELEF   | HONE  |  |   |   |
|   | 4.4.  | GOD  | DARD SPACE   | FLT                         |   |  | 01-9  |   |  |   |   |
| 12. CONTRACT<br>TYPE  | 13. CONTRACT NUMB   | ER   | 14. FLASH INDEX  | NUMBE                       | R 15. STAR  | T 16   | COMPLET   | 17  | STAT   | US  |   |
|   |   |  |  |                             |   |  |   |   |  |   |   |
| 18. MONITOR   |   | 19. AG   | ENCY   |                             | GM OFFICE   | <del></del>                                  | TELE  |   |  |   |   |
| BURKE. J.   | Р.  | NAS  | A HOOTES   | LOA                         | /ECS  | 2 (  | 02 <u>-7</u>  |   |  |   |   |
| 22. VENDOR  |   |  | 23. LOCATION   |                             |   |  | 1 4 b   | LIGHT<br>ATE  | 25. L  | EAD   | TIME  |
|   | T 7.40F   | <del> </del>   |  |                             |   |  | ш   |   | <u></u>  |   | 27.   |
| 26. INSTRUMEN   | <del></del>   |  |  |                             | 10565   | T.V.C.                                       | -   |   |  |   | SECURITY  |
|   | DER, 860 MHZ  | /TRAI  | NSMITTER,  | <u>6 GHZ</u>                | 78EUE   |  |   |   |  |   | LUNC  |
| 28. APPLICATIO  | N   |  |  |                             | +   |  | (F)   |   |  |   |   |
| COMM<br>30. PURPOSE   |   |  |  |                             | IATS-   | <u> </u>                                     |   |   |  |   |   |
| SMALL GRIOBSERVE IONUSPHEI ELECTRON VARIABLE 31.PRINCIPLES THE EXPENTIONS DI ING THE SIGNALS IN ADDIT QUALITY TIONAL P SARY SAT ING ANTE ESTIMATE OF A TAS TRANSLAT TV RELAY U.S. ARE STANDARD THE SIGN | TO DEVELOP OUND TERMINAL AND COMPARE IN TO DISPERSION OF OPERATION RIMENT CONSIDERECTLY TO SMILL ARGE ANTENN ARE SENT TO TOUR THE U.S., ROGRAMS TO VELLITE EIRP, NAA AND GENED THAT THE ROGRAMS TO VELLITE EIRP, NAA AND GENED THAT THE ROGRAMS TO VELLITE EIRP, NAA AND GENED THAT THE ROGRAMS TO VELLITE EIRP, NAA AND GENED THAT THE ROGRAMS TO VELLITE EIRP, NAA AND GENED THAT THE ROGRAMS SEITHER 325-1 VIDEO SIGNAL IS AMPLIFIED AMPLIFIED | LS F! WITH ON OUN I POUT STS ( STS ( THE STS ENT ENT ENT ENT ENT ENT ENT ENT ENT ENT | ROM SYNCRO THEOPETIC N SYSTEM P STATION L DE ADVICE  DF RELAYIN INEXPENSIV NO LOCAL T SATELLITE BLACK-AND- INDIAN GO GES THROUG LLITE USES S 80 WATTS VED VIDEO MARGIN GR THE SAME TO THE SATE AND ASSOCI (HARD-LIMI | AL PRECATION OF TELLINGATED | ALTITEDICT MANCE ON, A CONSUL SIGNA | UDE ION AS NO TAT LS VECOLIA ARAT LL 625 ERT | ***S  OTHE  OTH  FROM  FROM  FRASE  OREL  TO FI  BE S  ESTS  AT S  ED S | GEODIE HOUSE TO SEE TO | NDAF<br>FFE()<br>YSTI<br>OUNION<br>FY BOUNION<br>FTI()<br>EQU<br>FRE<br>LIN<br>EQU<br>FRE<br>LIN<br>60 | RY-STORM OF | TO<br>GOF<br>GTA-<br>GAT-<br>MHZ.<br>ECES-<br>LTT-<br>FISALENT<br>ENCY<br>SFOR<br>HE<br>ALENT<br>ENCY<br>SFOR<br>HE |
| ľ   | POLARIZED, 1<br>UIVALENT SYS  |  |  |                             | •   | ND   | LESS  | 5 TH  | ΔN   | 100   | ס   |
| 32. PHENOMEN  |   |  |  |                             |   |  |   |   |  |   | · -   |

IONOSPHERIC PROPAGATION ANOMALIES AT 860 MHZ.

33. MEASUREMENT RANGE

6 DB NOISE FIGURE

34. PRECISION AND ACCURACY NA

| 35. SPECTRAL RANGE                                     |  | 36. SPECTRAL R    | ESOLUTION    | 37. TIME CONSTA   | NT       |
|--|--|-------------------|--------------|-------------------|----------|
| 845.0 TO 875.0   | MHZ  | 20.               | MHZ          |                   |          |
| 38. FIELD OF VIEW                                      | 39. GROUND SWA   |                   | NM EDO       | A CEUCANUA        | ALTY     |
| 35 BY 35 DEG<br>40. ANGULAR RESOLUTION 41, SPATIAL RES | <u> </u>   | 1MB (10400        | NM FRU       | M GEOSYNCH        | ALII     |
| NA NA  | 02011011   |                   |              |                   |          |
| 42. POINTING ACCURACY 43. POINTING RAT                 | E 44. ALT  | ITUDE             | 45. INCLINA  | TION              |          |
|  | GEOS   | YNC               | С            | DEG               |          |
| 46. SPECIAL REQUIREMENTS                               |  |                   |              |                   |          |
| 47.0019015170  | AND THE PARTY OF T |                   | <del> </del> |                   |          |
| 860 MHZ TRANSMITTER, S                                 | /C TRANSPO   | NDER £ 30         | FT ANTE      | NNA -             |          |
| 48. WEIGHT 49. VOLUME                                  |  | ER 51. STANDBY PO |              |                   | BF       |
| 20 LB 1.5 CU F   | T 160 WAT  |                   |              |                   |          |
|  |  |                   | SHIELDING    |                   |          |
|  |  | NSITIVE           | 1            |                   | T10N     |
| 59. CALIBRATION  | 60. DATA RE  |                   |              | QUENCY OF OBSERVA |          |
| 62. TELEMETRY REQUIREMENTS                             | REALTIM  | <u> </u>          | <u>IA F</u>  | EW HOURS/D        | <u> </u> |
| SEE ITEM 31  |  |                   |              |                   |          |
|  |  | 1                 |              |                   |          |
|  |  | ·                 |              |                   |          |
| 63. ADVANTAGES AND LIMITATIONS                         |  |                   |              |                   |          |
|  |  |                   |              |                   |          |
| 64, REFERENCES   | <del></del>  |                   |              |                   |          |
| 1) HEFFERNAN, PAUL J.,                                 | (TRUST).   | GSFC. MAY         | 1968***      | 2) ATS-F S        | PACE-    |
| CRAFT PERFORMANCE REQU                                 |  |                   |              |                   |          |
| NO-ITI 0100. *** U.S                                   | INDIA ETV  | AGREEMENT,        | NASA PR      | ESS RELEAS        | E NO;    |
| 69-135, SEPT.18,1969.                                  |  |                   |              |                   | 1        |
|  |  |                   |              |                   |          |
| 65. HISTORICAL REMARKS                                 |  |                   | <u> </u>     |                   |          |
| EXPERIMENT TO BE INCLU                                 | DED IN ATS   | -G MISSION        | <u> </u>     |                   |          |
| -  |  |                   |              |                   |          |
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|                             |        | GREENBELT, MD. 2   | 20771    |                   |        |   |              |                                       |
|-----------------------------|--------|--------------------|----------|-------------------|--------|---|--------------|---------------------------------------|
| 1. TITLE                    |        |                    |          |                   |        | 2. ACR                                  | ONYM         | 3. EXP NO                             |
| VHF TRANSPONDER             |        |                    |          |                   |        | VTRA                                    | IN           |                                       |
| (TITLE CONT.)               |        |                    |          |                   |        | 4. RESUM                                | E DATE       | 5.<br>VERSION                         |
|                             |        |                    |          |                   |        | 0970                                    | 777          | 2 0004                                |
| 6. PRINCIPAL INVESTIGATOR   | 7. OR  | GANIZATION         |          |                   | 8. TE  | LEPHONE                                 |              |                                       |
| CORRIGAN. J.P.              | GODE   | DARD SPACE FL      | .T (     | ENTER             | 301    | -982-5                                  | 5042         |                                       |
| 9. CO-INVESTIGATOR          | 10. OR | GANIZATION         |          |                   | 11. TE | ELEPHONE                                |              | <del></del>                           |
|                             |        |                    |          |                   |        |   |              |                                       |
| 12. CONTRACT NUMB           | ER     | 14. FLASH INDEX NU | MBER     | 15. START<br>DATE | 16, CO | DATE 17                                 | STAT         | US                                    |
| NAS5-9593                   |        |                    |          | 05/6              | 5 12   | 166 DF                                  | ERA          | TIONAL                                |
| 18. MONITOR                 | 19. AG | ENCY               | 20. PG   | M OFFICE          | 21. T  | ELEPHONE                                | :            |                                       |
| BURKE, J.R.                 | NAS    | A HDQTRS           | DA       | 'ECS              | 202    | -755-2                                  | 322          |                                       |
| 22. VENDOR                  |        | 23. LOCATION       |          |                   |        | 24. FLIGHT<br>DATE                      | 25. LE       | EAD TIME                              |
| HUGHES-RES + DEVELOP        | DIV    | CULVER CITY,       | C A      | LIFOR             | NIA    | 12/66                                   | NΔ           | · · · · · · · · · · · · · · · · · · · |
| 26. INSTRUMENT TYPE         |        |                    |          | ,                 |        |   |              | 27.<br>SECURITY                       |
| TRANSPONDER, ACTIVE F       | FREQU  | JENCY-TRANSLA      | TIC      | )N                |        |   |              | UNC                                   |
| 28. APPLICATION             |        |                    |          | 29. SPACE         | CRAFT  | Γ                                       |              |                                       |
| COMM, OCEAN                 |        |                    |          | ATS 1             |        | * |              |                                       |
| 30. PURPOSE                 |        |                    |          |                   |        |   |              |                                       |
| PRIMARY-DEMONSTRATE F       | EAS    | IBILITY OF PR      | OVI      | DING              | CONT   | INUNUS                                  | 5 VO         | ICE                                   |
| COMMUNICATIONS LINK E       | 3ETWI  | EEN A GROUND       | CON      | ITROL             | STAT   | ION AN                                  | ND A         | IP-                                   |
| CRAFT WITHIN SATELLIT       | re R/  | ANGE.***SE CON     | DAF      | Y-DEM             | ONST   | RATE F                                  | EAS          | IBIL-                                 |
| ITY OF OPERATING A ME       | ETEOF  | ROLOGICAL NET      | WOF      | K IN              | WHIC   | H DATA                                  | FR           | OM                                    |
| SENSOR PACKAGES ARE (       |        |                    |          |                   |        |   |              |                                       |
| TRANSMITTED TO THE NE       |        |                    |          |                   |        |   |              |                                       |
| 31. PRINCIPLES OF OPERATION |        |                    |          |                   |        |   |              |                                       |
| THE VHF COMMUNICATION       | 1S I   | NSTRUMENT IS       | AN       | ACTIV             | E FR   | EQUENC                                  | . Y T        | RANS                                  |
| LATION LIMITING (CLAS       |        |                    | •        |                   |        |   |              |                                       |
| AND TRANSMITS THROUGH       | 1 AN   | 8-ELEMENT, P       | HAS      | SED-ARI           | RAY    | ANTENN                                  | VA.          | IN-                                   |
| COMING SIGNALS AT 149       | €.22   | MHZ APE RECE       | IVE      | D ON              | EACH   | DIPOL                                   | . <b>E</b> E | LEMENT                                |
| ROUTED THROUGH A DIPL       |        |                    |          |                   |        |   |              |                                       |
| AND SHIFTED IN PHASE        | TO (   | COMPENSATE FO      | R T      | THE RE            | LATI   | VE POS                                  | ITI          | ON OF                                 |
| EACH DIPOLE ANTENNA.        | THE    | E DUTPUTS OF       | EAC      | H REC             | EIVE   | R ARE                                   | ΙN           | PHASE                                 |
| ONLY FOR THOSE SIGNAL       | ST     | HAT ORIGINATE      | . 01     | EART              | н.     | REFERE                                  | NCE          |                                       |
| SINUSOIDS USED TO DRI       | IVE 1  | THE WAVEFORM       | GEN      | IERATO            | R AR   | E OBTA                                  | INE          | D FROM                                |
| THE SAME PHASED-ARRAY       | ( CON  | NTROL ELECTRO      | NIC      | S USE             | D TO   | AIM 1                                   | THE          | MICRO-                                |
| WAVE BEAM TOWARD EART       | ГН.    | THE 8 RECEIV       | /ER      | OUTPU             | TS A   | RE SUN                                  | <b>MED</b>   | TO-                                   |
| GETHER, FILTERED, DOW       |        |                    |          |                   |        |   |              |                                       |
| MHZ, AMPLIFIED, AND F       | ASSE   | ED THROUGH A       | CRY      | STAL I            | FILT   | ER TO                                   | LIM          | IT THE                                |
| RECEIVER BANDWIDTH TO       | 100    | KHZ. THE I         | FI       | S THE             | Ν ΔΜ   | PLIFIE                                  | Đ.           | UP-                                   |
| CONVERTED TO 135.6 MH       |        |                    |          |                   |        |   |              |                                       |
| EQUAL PARTS. EACH OF        |        |                    |          |                   |        |   |              |                                       |
| WHERE IT IS AMPLIFIED       |        |                    |          |                   |        |   |              |                                       |
| POWER LEVEL OF 5 WATT       |        |                    |          |                   |        |   |              |                                       |
| THROUGH ITS RESPECTIV       |        |                    |          |                   |        |   |              |                                       |
|                             |        |                    | <b>-</b> |                   |        |   |              |                                       |
| 32. PHENOMENA OBSERVED      |        |                    |          |                   |        |   |              |                                       |
| DATA FROM OBSERVATION       | V PL/  | ATFORMS AND G      | ROL      | IND COL           | NTRO   | L STAT                                  | ION          | S                                     |
| 33. MEASUREMENT RANGE       |        |                    | <b>_</b> |                   |        |   |              |                                       |
|                             |        |                    |          |                   |        |   |              |                                       |
| 34. PRECISION AND ACCURACY  |        |                    |          |                   |        |   |              |                                       |

RECEIVER NOISE OBSERVATION PLATFORMS AND GROUND CONTROL STATIONS

| 35. SPECTRAL RANGE                      |                 | 36. SPECTRAL RESOL                      | UTION 37. TIME CONSTANT               |
|---|-----------------|---|---------------------------------------|
| 135.6 In 149.22                         |                 | ΝΔ                                      |                                       |
| 38. FIELD OF VIEW                       | 39. GROUND SWA  |   | FROM GEO-SYNCH ALT                    |
| 17.3 DEG                                | CLUMB-1U-L      | TWD ( A LOO MM)                         | FROM GEO-STACT ALT                    |
| NA NA                                   |                 |   |                                       |
| 42. POINTING ACCURACY 43. POINTING RATE |                 |   | INCLINATION                           |
| NA NA                                   | SYNC            | H CIRCULAR E                            | DUATORIAL POSIGRADE                   |
| 46. SPECIAL REQUIREMENTS                |                 |   |                                       |
| 47. COMPONENTS                          |                 | - 10 - 10 - 10 - 10 - 10 - 10 - 10 - 10 |                                       |
| 8 ANTENNA SYSTEMS , 8 R                 | ECEIVERS,       | 8 TRANSMITTE                            | RS, AND MISC EQUIP                    |
| 48. WEIGHT 49. VOLUME                   | 50. AVERAGE POW |   | 52. PEAK POWER   53. MTBF             |
| 30 1B                                   | UCLEAR 57. INT  | HERMAL<br>ERFERENCE 58. SHIE            | 90 WATTS                              |
| SOURC/SEN                               | RFERENCE        | HPERENCE JO. SITTE                      | LDING                                 |
| 59. CALIBRATION                         | 60. DATA REC    | OVERY                                   | 61. FREQUENCY OF OBSERVATION          |
| NA                                      | REALTIM         | E TELEMETRY                             | CONTINUOUS                            |
| 62. TELEMETRY REQUIREMENTS              |                 |   |                                       |
| 100 KHZ BANDWIDTH                       |                 |   |                                       |
|   |                 |   |                                       |
| 63. ADVANTAGES AND LIMITATIONS          |                 |   |                                       |
|   |                 |   |                                       |
| 64. REFERENCES                          |                 |   | 33.31                                 |
| 1) VHE REPEATER EXPERIM                 | ENT-FINAL       | REPORT. HUGH                            | ES AIRCRAFT CO. NASA                  |
| CONTRACT NO. 5-9593. F                  | EB 1, 1967      | .***2)VHF RE                            | PEATER EXPERIMENT                     |
| FOR ATS-C. FINAL REPOR                  |                 | AIRCRAFT CO.                            | , NASA CONTRACT NO.                   |
| NAS 5-10290, NOV 1967.                  |                 |   |                                       |
|   |                 |   | · · · · · · · · · · · · · · · · · · · |
| 65. HISTORICAL REMARKS                  |                 |   |                                       |
| SIMILAR TO INSTRUMENT                   | FLOWN ON A      | <u>TS 3.</u>                            |                                       |
| ı                                       |                 |   |                                       |
|   |                 |   |                                       |
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|                      |                   |              | GREENBELT    | Γ, MD. 2    | 20771      |                   |        |                    |           |                 |
|----------------------|-------------------|--------------|--------------|-------------|------------|-------------------|--------|--------------------|-----------|-----------------|
| 1. TITLE             |                   |              |              |             |            |                   |        | 2. 4               | CRONYM    | 3. EXP NO       |
| VHE TRANS            | PONDER            |              |              |             |            |                   |        | VΤ                 | RAN       |                 |
| (TITLE CONT.)        | )                 |              |              |             |            |                   |        | 4. A               | SUME DATE | 5.<br>VERSION   |
|                      |                   |              |              |             |            |                   |        | 09                 | /01/7     |                 |
| 6. PRINCIPAL IN      | IVESTIGATOR       | <u> </u>     | GANIZATION   |             |            |                   | 8. TE  | LEPHO              | NE        |                 |
| CORRIGAN,            | J.P.              | GODD         | ARD SPA      | CE FL       | TCE        | NTER              | 301    | -982               | -5042     |                 |
| 9. CO-INVESTIG       |                   |              | GANIZATION   |             |            |                   | 11. TE | LEPHO              | NE        |                 |
|                      |                   |              |              |             |            |                   |        |                    |           |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER           | 14. FLASH IN | IDEX NU     | MBER       | 15. START<br>DATE | 16. CO | MPLETION<br>DATE   | 17. STAT  | US              |
|                      | NAS5-10290        |              |              |             |            | 11/66             | 11.    | /67                | OPERA     | TIONAL          |
| 18. MONITOR          |                   | 19. AG       | ENCY         |             | 20. PGM    | OFFICE            | 21. TI | ELEPHO             | ONE       |                 |
| BURKE, J.            | R •               | NASA         | HDQTRS       |             | OA/E       | CS                | 202    |                    | -2322     |                 |
| 22. VENDOR           |                   |              | 23. LOCATIO  | ON          |            |                   |        | 24. FLIGHT<br>DATE | 25. L     | EAD TIME        |
| HUGHES R             | AND D             |              | CULVER       | CITY,       | CAL        | <u>IFORN</u>      | 114    | 11/6               | 7 NA      |                 |
| 26. INSTRUMEN        | T TYPE            |              |              |             |            |                   |        |                    |           | 27.<br>SECURITY |
| REPEATER,            | ACTIVE FREQ       | UENC         | Y TRANS      | LATIC       | N          |                   |        |                    |           | UNC             |
| 28. APPLICATIO       | N                 |              |              |             |            | 9. SPACE          | CRAFT  |                    |           |                 |
| COMM, OCE            | AN                |              |              |             |            | TS 3              |        |                    |           |                 |
| 30. PURPOSE          |                   |              |              |             |            |                   |        |                    |           |                 |
|                      | EMONSTRATE F      |              |              |             |            |                   |        |                    |           |                 |
|                      | TIONS LINK B      |              |              |             |            |                   |        |                    |           |                 |
|                      | HIN SATELLIT      |              |              |             |            |                   |        |                    |           |                 |
|                      | OPERATING A       |              |              |             |            |                   |        |                    |           |                 |
| SENSOR PA            | CKAGES ARE C      | OLLE         | CTED AT      | A CE        | NTRA       | L ST              | OITA   | N AN               | D THE     | N               |
| TRANSMITT            | ED TO THE NE      | TWOR         | K ALL V      | IA SA       | TELL       | ITE.              |        |                    |           |                 |
| 31. PRINCIPLES       |                   |              |              |             |            |                   |        |                    |           |                 |
|                      | RUMENT IS AN      |              |              |             |            |                   |        |                    |           |                 |
| ER THAT R            | ECEIVES AT A      | FRE          |              |             |            |                   |        |                    |           |                 |
|                      | OF 135.6 MH       |              | THE REP      |             |            |                   |        |                    |           |                 |
|                      | BUGH AN 8-ELE     |              |              |             |            |                   |        |                    |           |                 |
|                      | OF THE TYPE L     |              |              |             |            |                   |        |                    | ATS       | 3               |
|                      | ER IS A LINE      |              |              |             |            |                   |        |                    | SATUR     | ATED            |
|                      | OF ATS 1. 1       |              |              |             |            |                   |        |                    |           |                 |
| DIPOLE EL            | EMENT, ROUTE      | ED TH        | IROUGH A     | DIPL        | .EXEF      | R. AMF            | PLIF   | IED                | BY A      | LOW             |
| NOISE REC            | CEIVER, AND S     | SHIFT        | TED IN P     | HASE        | TO C       | COMPEN            | ISAT   | E FO               | R THE     | RELA-           |
|                      | TION OF EACH      |              |              |             |            |                   |        |                    |           |                 |
|                      | IN PHASE ON       |              |              |             |            |                   |        |                    |           |                 |
| EARTH. T             | HE 8 RECEIVE      | ER OU        | JTPUTS A     | RE SI       | JMME       | TOGE              | THE    | R, F               | ILTER     | ED AND          |
|                      | ERTED TO A 2      |              |              |             |            |                   |        |                    |           |                 |
| CRYSTAL F            | FILTER TO LIN     | AIT T        | THE RECE     | IVER        | BAN        | O WID             | TH T   | 0 10               | O KHZ     | . THE           |
|                      | N AMPLIFIED       |              |              |             |            |                   |        |                    |           |                 |
| LEVELS AF            | RE OBTAINED E     | 3 <b>Y</b> A | POWER S      | PLITI       | ING.       | , 7-W/            | AY H   | YBR I              | D. E      | ACH OF          |
| THE SIGNA            | LS IS THEN A      | MPLI         | FIED, P      | HASE        | SHIF       | TED A             | AND    | <b>FURT</b>        | HER A     | MPLI-           |
| FIELD TO             | AN OUTPUT LE      | EVEL         | OF 5 WA      | TTS.        | THE        | TRAN              | IMZV   | TTER               | UNIT      | S IN-           |
|                      | 3 DB ATTENL       |              |              |             |            | AN BE             | CON    | TROL               | LED E     | ITHER           |
| BY GROUND            | STATION OR        | SPAC         | CECRAFT      | CLOCK       | <b>( •</b> |                   |        |                    |           |                 |
| 32. PHENOMEN         | A OBSERVED        |              |              |             |            |                   |        |                    |           |                 |
|                      | OBSERVATION       | I PLA        | TFORMS       | AND (       | GROUN      | ND COM            | ITRO   | L ST               | ATION     | S               |
| 33. MEASUREMI        | ENT RANGE         |              |              | <del></del> |            |                   |        |                    |           |                 |
|                      |                   |              |              |             |            |                   |        |                    |           |                 |
| 34. PRECISION        | AND ACCURACY      |              |              |             |            |                   |        |                    |           |                 |

RECEIVER NOISE FIGURE < 4.0 DB

| 35. SPECTRAL RANGE                              |        |                                       | 36           | . SPECTRA  | L RESOL  | UTION   | 37. TIME CONSTANT     |
|---|--------|---------------------------------------|--------------|------------|----------|---------|-----------------------|
| 135.6 TO 149.22                                 |        | MHZ                                   | N            | Α          |          |         |                       |
| 38. FIELD OF VIEW                               |        | GROUND                                |              | -          | •        |         |                       |
|   |        |                                       | I-LIM        | B(9700     | ) NM)    | FROM    | GED-SYNCH ALT         |
| 40. ANGULAR RESOLUTION 41. SPATIAL RES          | SOLU   | ITION                                 |              |            |          |         |                       |
| NA NA   |        |                                       |              |            |          |         |                       |
| 42. POINTING ACCURACY 43. POINTING RAT          | TE     | [                                     | ALTITE       |            |          | INCLINA |                       |
| NA NA   |        | <u> SY</u>                            | NCH          | CIRCUL     | AR EQ    | UATUR   | TAL POSIGRADE         |
| 46. SPECIAL REQUIREMENTS                        |        |                                       |              |            |          |         |                       |
|   |        |                                       | <del></del>  |            |          |         |                       |
| 47. COMPONENTS                                  | E C 0  | TUEDE                                 | - 6          | YO A KI CK | TTTES    | C Ak    | ID MISC EQUIP         |
| 8 ANTENNA SYSTEMS, 8 R<br>48. WEIGHT 49. VOLUME |        | O. AVERAGE                            | -            | 1          |          |         | K POWER 53. MTBF      |
| 34 LB   | +      | O. AVENAGE                            | POWER        | 31.31410   | BITOMEN  |         | WATTS                 |
|   | MUCLE  | AR                                    | 57. THER     | MAL        | 58. SHIE |         | WATT 5                |
| SOURC/SEN                                       | IEHFER | ENCE                                  | INTERF       | KENCE      | 50. GHE  |         |                       |
| 59. CALIBRATION                                 |        | 60. DATA                              | RECOV        | /FRY       |          | 61. FRE | QUENCY OF OBSERVATION |
| NA  |        |                                       |              | TELEME     | TRY      | CONT    | INUOUS                |
| 62. TELEMETRY REQUIREMENTS                      |        | , = /                                 | <del>_</del> |            |          |         |                       |
| 100 KHZ BANDWIDTH                               |        |                                       |              |            |          |         |                       |
|   | •      |                                       |              |            |          |         |                       |
|   |        |                                       |              |            |          |         | :                     |
| 63. ADVANTAGES AND LIMITATIONS                  |        |                                       |              | •          |          |         |                       |
| MAJOR DIFFERENCE FROM                           |        |                                       |              |            |          | THE A   | DDITION OF A          |
| SMALL ATTENUATOR TO EA                          | CH     | OF TH                                 | E 8          | ASSEME     | BLES.    |         |                       |
| 64. REFERENCES                                  |        |                                       |              |            |          |         |                       |
| 1) VHE REPEATER EXPERI                          |        |                                       |              |            |          |         |                       |
| NO. NAS5-10290. HUGHE                           |        |                                       |              |            |          |         |                       |
| 1967.***2)VHF REPEATER                          |        |                                       | -            |            |          |         | ISA CUNTRACT          |
| NO. NAS 5-10290. HUGH                           | F 2    | AIRCK                                 | AFI          | CU, FE     | B 130    | f •     |                       |
|   |        |                                       |              |            |          |         |                       |
|   |        |                                       |              |            |          |         |                       |
| 65. HISTORICAL REMARKS                          |        |                                       | <u>.</u>     | ·          |          |         |                       |
| 65. HISTORICAL REMARKS                          | ·      | · · · · · · · · · · · · · · · · · · · | -            |            |          |         |                       |
| 65. HISTORICAL REMARKS                          |        |                                       |              |            |          |         |                       |
| 65. HISTORICAL REMARKS                          |        |                                       |              |            |          |         |                       |
| 65. HISTORICAL REMARKS                          |        |                                       |              |            |          |         |                       |
| 65. HISTORICAL REMARKS                          |        |                                       |              |            |          |         |                       |
| 65. HISTORICAL REMARKS                          |        |                                       |              |            |          |         |                       |
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|   |        |                                       |              |            |          |         |                       |
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|   | κ.     | ×                                     |              |            |          |         |                       |
|   | e.     |                                       |              |            |          |         |                       |
|   | e.     | ×                                     |              |            |          |         |                       |
|   | e.     |                                       |              |            |          |         |                       |
|   | e.     |                                       |              |            |          |         |                       |
|   | κ.     |                                       |              |            |          |         |                       |
|   | κ.     |                                       |              |            |          |         |                       |
|   | κ.     |                                       |              |            |          |         |                       |
|   |        |                                       |              |            |          |         |                       |
|   |        |                                       |              |            |          |         |                       |

| 1. TITLE             |                   |        |        |               |          |                   |                  | 2.                | ACRONY   | /M    | 3.  | EXP NO          |
|----------------------|-------------------|--------|--------|---------------|----------|-------------------|------------------|-------------------|----------|-------|-----|-----------------|
| WEATHER F            | ACSIMILE EXP      | ERIM   | 1ENT   |               |          |                   |                  | W                 | EFAX     |       |     |                 |
| (TITLE CONT.         | )                 |        |        |               |          |                   |                  | 4.                | RESUME D | ATE   |     | 5.<br>VERSION   |
|                      |                   |        |        |               |          |                   |                  | C.                | 9/01     | /7    | 2   | 0005            |
| 6. PRINCIPAL II      | NVESTIGATOR       | 7. OR  | GANIZ  | ATION         |          |                   | 8. T             | ELEPH             | ONE      |       |     |                 |
| WISHNA, S            |                   | GODE   | ) AR D | SPACE FL      | T C      | ENTER             | 301              | <b>-9</b> 8       | 2-50     | 42    |     |                 |
| 9. CO-INVESTIG       | ATOR              | 10. OR | GANIZ  | ATION         |          |                   | 11. T            | ELEPH             | ONE      |       |     |                 |
|                      | ). W.             | NOAA   | 1/NE   | SC            |          |                   | 301              | l <del>-</del> 65 | 5-40     | 00    |     |                 |
| 12. CONTRACT<br>TYPE | 13. CONTRACT NUMB | ER     | 14. F  | LASH INDEX NU | MBER     | 15. START<br>DATE | 16. <sup>C</sup> | OMPLETION<br>DATE | 17. ST   | AT    | US  |                 |
|                      | NAS5-9593         |        |        |               |          |                   | 12               | 2/66              | OPE      | RA    | TI  | DNAL            |
| 18. MONITOR          |                   | 19. AG | ENCY   |               | M OFFICE | 21. TELEPHONE     |                  |                   |          |       |     |                 |
| BURKE, J.            | . R .             | NASA   | A HD   | QTRS          | OA/      | ECS               | 202              | 2-75              | 5-23     | 22    |     |                 |
| 22. VENDOR           |                   |        | 23. L  | OCATION       |          |                   |                  | 24. FLIGI<br>DATE | 17 25    | i. LI | EAC | TIME            |
| HUGHES AT            | RCRAFT CO         |        | FL     | SEGUNDO,      | CAL      | IFORNI            | Α                | 12/               | 66 N     | Α     |     | -               |
| 26. INSTRUMEN        | T TYPE            |        |        |               |          |                   |                  |                   |          |       |     | 27.<br>SECURITY |
| TRANSPOND            | )ER               |        |        |               |          |                   |                  |                   |          |       |     | UNC             |
| 28. APPLICATIO       | N                 |        |        |               |          | 29. SPACE         | CRAF             | T                 |          |       |     |                 |
| MET. COMM            | 1                 |        |        |               |          | ATS 1             |                  |                   |          |       |     |                 |
| 30. PURPOSE          |                   |        |        |               |          |                   |                  |                   |          |       |     |                 |
|                      |                   |        |        |               |          |                   |                  |                   |          |       |     |                 |

PRIMARY-TO DETERMINE OPERATIONAL FEASIBILITY OF DISSEMINATING METEOROLOCICAL DATA AND SATELLITE CLOUD CAMERA PICTURES FROM A CENTRAL SOURCE TO WIDELY SCATTERED RECEIVING UNITS UTILIZING A VHF TRANSPONDER SYSTEM ONBOARD AN EARTH SYNCHRONOUS SPACECRAFT. \*\*\*SECONDARY- TO EXPLORE FEASIBILITY OF INCREASING THE AMOUNT OF DATA AVAILABLE TO STATIONS RECEIVING APT PHOTOGRAPHS.

31. PRINCIPLES OF OPERATION

THIS WEFAX EXPERIMENT, WHICH IS SIMILAR TO THE ONE UTILIZED BY ATS 3, IS DIFFERENT FROM OTHER ATS 1 METEOROLOGICAL EXPERIMENTS IN THAT IT HAS NO UNIQUE FLYING HARDWARE. IT IS PART OF THE ATS 1 VHF EXPERIMENT AND USES THE VHF TRANSPONDER AS A DATA RELAY. THIS TRANSPONDER RECEIVES AT 149.22 MHZ AND TRANSMITS AT 135.60 MHZ. THE FEASIBILITY TESTS CONDUCTED BY WEFAX INCLUDE: MASS DIS-TRIBUTION OF WEATHER DATA DIRECT TO APT USERS; REBROADCASTING SYNCHRONOUS ALTITUDE EARTH PICTURES VIA APT FORMAT: PROPOSED MASS COLLECTIONS OF HYDROLOGY DATA VIA ATS 1 RELAY; AND PROPOSED LINE ISLANDS EXPERIMENT BY THE NAT CTR FOR ATMOS RES. IN OPERA-TION, WEATHER FACSIMILE CHARTS AND SATELLITE CLOUD COVER PIC-TURES ARE SENT PERIODICALLY VIA LANDLINE FROM THE NAT MET CTR. ESSA, AT SUITLAND, MD., TO THE NASA ATS GROUND STATION AT MOJAVE CALIF. FROM THERE, THE PROCESSED INFORMATION IS TRANSMITTED TO ATS 1 FOR RELAY TO ALL PARTICIPATING APT STATIONS WITHIN THE RECEPTION AREA. DAILY WEFAX SCHEDULES ARE PROGRAMMED TO PROVIDE MEANINGFUL DATA TO THE MAXIMUM NUMBER OF PARTICIPATING APT STA-TIONS POSSIBLE, NUMBERING ABOUT 50.

#### 32. PHENOMENA OBSERVED

VHF TRANSMISSIONS FROM ATS GROUND STATIONS GIVING WEATHER DATA
33. MEASUREMENT RANGE

#### 34. PRECISION AND ACCURACY

TRANSPONDER NOISE FIGURE 4.5 DB; BANDWIDTH 100 KHZ

| 35. SPECTRAL RANGE   |   |           | 36. SPECTRAL RESOLUTION 37. TIME CONSTA |            |       |            |  |           | CONSTAN     | ΙT     |  |  |
|--|---|-----------|---|------------|-------|------------|--|-----------|-------------|--------|--|--|
| 149.22 AND 135.60  |   |           |   |            |       |            |  |           |             |        |  |  |
| 38. FIELD OF VIEW  |   | UND SWATH |   |            |       |            |  |           |             |        |  |  |
| 17.3 DEG LIMB-TO-LIMB (9700 NM) FROM GED-SYNCH ALT   |   |           |   |            |       |            |  |           |             |        |  |  |
|  |   |           |   |            |       |            |  |           |             |        |  |  |
| 42. POINTING ACCURACY 43. POINTING RATE 44. ALTITUDE 45. INCLINATION   |   |           |   |            |       |            |  |           |             |        |  |  |
| SYNCH CIRCULAR EQUATORIAL POSIGRADE  |   |           |   |            |       |            |  |           |             |        |  |  |
| 46. SPECIAL REQUIREMENTS   |   |           |   |            |       |            |  |           |             |        |  |  |
| 47. COMPONENTS   |   |           |   |            |       |            |  |           |             |        |  |  |
| VHE TRANSPONDER. ANTENNA SYSTEM. DIPLEXER  |   |           |   |            |       |            |  |           |             |        |  |  |
| 48. WEIGHT 49. VOLUME 50. AVERAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF  |   |           |   |            |       |            |  |           |             |        |  |  |
| 29 IB  |   |           | J                                       |            |       |            |  |           |             |        |  |  |
| and the second s | UCLEAR<br>ERFERENCE                     | 57. INTE  | RFER                                    | AL<br>ENCE | 58. S | HIEL       | DING   |           |             |        |  |  |
| SOURC/SEN  | len ne                                  | ATA REC   | ·0V                                     | EDV        |       |            | I 61 FRE   | QUENCY OF | OBSERVATION | ON     |  |  |
| OS. GALISIA TION   | 00. 0                                   | TIA NEC   |   |            |       |            | <del>                                     </del> | PROGRA    |             |        |  |  |
| 62. TELEMETRY REQUIREMENTS   |   |           |   |            |       |            |  | NUOSA     |             |        |  |  |
| 3 KHZ INFORMATION BAND   | HIDIH                                   |           |   |            |       |            |  | -         |             |        |  |  |
|  |   |           |   |            |       |            |  |           |             |        |  |  |
| 63. ADVANTAGES AND LIMITATIONS   |   |           |   |            |       |            |  |           | . 50        |        |  |  |
| MULTIPLEXING TO ENABLE   | 400TT                                   |           |   |            | · ·   |            | TDANIS   | MITTE     | DHAS        | NOT    |  |  |
| REEN COMPLETELY SUCCESS  |   |           | _ (                                     | јата т     | וט פ  | ) <u>-</u> | IKAN   | SMITTE    | U HAS       | ויטויו |  |  |
| 64. REFERENCES   |   |           |   |            |       |            |  |           | 2           |        |  |  |
| 1) ALLIED RES ASSOC, INC   | .: NAS                                  | A/ESS     | SΑ                                      | WEFA)      | ( E)  | (PE        | RIMEN  | IT EVA    | LUATIO      | ON     |  |  |
| REPORT (ATS 1), CHANGE   |   |           |   |            |       |            |  |           |             |        |  |  |
| TERIM REPORT ON SAT ME   |   |           |   |            |       |            |  |           |             | I DGE  |  |  |
| MASS.,1967.***3)ATS B   1966.***4) DRUMMOND, R   |   |           |   |            |       |            |  |           |             | A T    |  |  |
| ATS SYSTEMS ENGRS TRAIL  |   |           |   |            |       |            |  | PRES      | CMIED       | A 1.   |  |  |
| 65. HISTORICAL REMARKS   | * • • • • • • • • • • • • • • • • • • • |           |   |            |       | ,          |  |           |             |        |  |  |
| SIMILAR TO ATS 3 WEFAX   | •                                       |           | · <i>;</i> -                            |            |       |            |  |           |             |        |  |  |
|  |   |           |   |            |       |            |  |           |             |        |  |  |
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|  |   |           |   |            |       |            |  |           |             |        |  |  |
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|  |   |           |   |            |       |            |  |           |             |        |  |  |

|                               |  |             | GREE                             | NDELI,  | IVID.    | 20//1   |                   |        |                           |          |       |           |                 |  |  |
|-------------------------------|--|-------------|----------------------------------|---------|----------|---------|-------------------|--------|---------------------------|----------|-------|-----------|-----------------|--|--|
| 1. TITLE 2. ACRONYM 3. EXP No |  |             |                                  |         |          |         |                   |        |                           |          |       |           | XP NO           |  |  |
| WEATHER FACSIMILE EXPERIMENT  |  |             |                                  |         |          |         |                   |        |                           |          |       | FAX       |                 |  |  |
| (TITLE CONT.)                 |  |             |                                  |         |          |         |                   |        | 4.1                       | RESUME   | DATE  | 5         | ERSION          |  |  |
|                               |  |             |                                  |         |          |         |                   |        | 0.0                       | 770      | 177   | 2         | 1005            |  |  |
| 6. PRINCIPAL IN               | IVESTIGATOR                                    | 7. OR       | GANIZ                            | ATION   |          |         |                   | 8. TI  | ELEPHO                    | NE       |       |           |                 |  |  |
| HOLMES, D                     | ). W.  | NOA         | /NE                              | SC      |          |         |                   | 301    | -65                       | 5-4      | 000   |           |                 |  |  |
| 9. CO-INVESTIG                |  | 10. OR      | GANIZ                            | ATION   |          |         |                   | 11. T  | ELEPHO                    | ONE      |       |           |                 |  |  |
| WISHNA, S                     | ) •  | GOD         | DAR D                            | SPAC    | E FL     | T CE    | NTER              | 301    | -982                      | 2 - 5    | 042   |           |                 |  |  |
|                               | 13. CONTRACT NUMB                              | ER          | 14. FL                           | ASH INE | DEX NU   | MBER    | 15. START<br>DATE | 16, C  | 16. COMPLETION 17. STATUS |          |       |           |                 |  |  |
|                               |  |             |                                  |         |          |         |                   | 11     | 167                       | OP       | ERA   | TIC       | INAL            |  |  |
| 18. MONITOR                   | <u>- 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1</u> | 19. AG      | ENCY                             |         |          | 20. PGM | OFFICE            | 21. 1  | ELEPH                     | ONE      |       |           | 7               |  |  |
| BURKE. J.                     | R.   | NASA        | A HD                             | QTRS    |          | OA/E    | CS                | 202    | 2-75                      | 5-2      | 322   |           |                 |  |  |
| 22. VENDOR                    |  |             | 23. LOCATION 24. FLIGHT DATE 25. |         |          |         |                   |        |                           |          |       | LEAD TIME |                 |  |  |
| HUGHES AT                     | RCRAFT CO                                      |             | EL.                              | SEGUN   | NDO.     | CALI    | FORNI             | [ Δ    | 11/6                      |          | NA    |           |                 |  |  |
| 26. INSTRUMEN                 | T TYPE   |             |                                  |         | ··       |         |                   |        |                           |          |       |           | 27.<br>SECURITY |  |  |
| TRANSPOND                     | FR. VHF  |             |                                  |         |          |         | <del></del>       |        |                           |          |       |           | UNC             |  |  |
| 28. APPLICATIO                |  |             |                                  |         |          | 2       | 9. SPACE          | CRAF   | T                         |          |       |           |                 |  |  |
| MET. COMM                     | 1  |             |                                  |         |          |         | TS 3              |        |                           |          |       |           |                 |  |  |
| 30. PURPOSE                   | <u>'</u>                                       |             |                                  |         |          |         | <u> </u>          |        |                           |          |       |           |                 |  |  |
| PRIMARY -                     | - TO TRANSMIT                                  | FΔC         | SIM                              | IIF V   | VEATI    | HER I   | ATA               | THRO   | JUGH                      | TH       | ĖΑ    | TS        | 3               |  |  |
|                               | TO PARTICI                                     |             |                                  |         |          |         |                   |        |                           |          |       |           |                 |  |  |
|                               | CTED SPIN-SCA                                  |             |                                  |         |          |         |                   |        |                           |          |       |           |                 |  |  |
|                               | EADOUT STATIO                                  |             |                                  |         |          |         |                   |        |                           |          |       |           |                 |  |  |
|                               | NT OF DATA AN                                  |             |                                  |         |          |         |                   |        |                           |          |       |           | 1               |  |  |
|                               | S SATELLITES                                   |             | 10L L                            | , ,     |          |         | 10 317            | - 1 .  | 5115                      | , , ,    | ,,, _ |           | •               |  |  |
| 31. PRINCIPLES                |  | 2.          |                                  |         |          |         |                   |        |                           |          |       |           |                 |  |  |
| THIS WEE                      | X EXPERIMENT                                   | T . W.      | 11CH                             | 15 9    | TMI      | AR 1    | In THI            | - 01   | VF II                     | TII      | 17F   | ח ו       | 3 🗸             |  |  |
|                               | DIFFERENT                                      |             |                                  |         |          |         |                   |        |                           |          |       |           |                 |  |  |
| · -                           | T HAS NO UN                                    |             |                                  |         |          |         |                   |        |                           |          |       |           |                 |  |  |
|                               | PERIMENT AND                                   |             |                                  |         |          |         |                   |        |                           |          |       |           |                 |  |  |
|                               | SPONDER RECI                                   |             |                                  |         |          |         |                   |        |                           |          |       |           |                 |  |  |
|                               | FEASIBILITY                                    |             |                                  |         |          |         |                   |        |                           |          |       |           |                 |  |  |
|                               | N OF WEATHER                                   |             |                                  |         |          |         |                   |        |                           |          |       |           |                 |  |  |
|                               | DUS ALTITUDE                                   |             |                                  |         |          |         |                   |        |                           |          |       |           |                 |  |  |
|                               | ECTIONS OF                                     |             |                                  |         |          |         |                   |        |                           | _        | LOF   |           |                 |  |  |
|                               | ATHER FACSIM                                   |             |                                  |         |          |         |                   |        |                           | -        | •     |           | -               |  |  |
| •                             | E SENT PERIO                                   |             |                                  |         |          |         |                   |        |                           |          |       |           |                 |  |  |
|                               | DGICAL CENTER                                  |             |                                  |         |          |         |                   |        |                           |          |       |           | TS              |  |  |
|                               | TATION AT MO.                                  | •           | _                                |         |          |         | -                 | -      |                           |          |       |           |                 |  |  |
|                               | RANSMITS THE                                   |             |                                  |         |          |         |                   |        |                           |          |       |           |                 |  |  |
|                               | R MINUTE, AND                                  |             |                                  |         |          |         |                   |        |                           |          | RTI   |           |                 |  |  |
|                               | PT STATIONS                                    |             |                                  |         |          |         |                   |        |                           |          |       |           |                 |  |  |
|                               | USEFULNESS.                                    |             |                                  |         |          |         |                   |        |                           |          |       |           | <b>T</b> O      |  |  |
|                               | FOR CORRELAT                                   |             |                                  |         |          |         |                   |        |                           |          |       |           |                 |  |  |
|                               | TANCE AND AN'                                  |             |                                  |         |          |         |                   |        |                           |          |       |           |                 |  |  |
|                               | S CAN BE INCI                                  |             |                                  |         |          |         |                   |        |                           | 1 J (    | , r.E | . C L     | 1 V —           |  |  |
| 32. PHENOMENA                 |  |             | J 11V                            | 1116    | MAL      | H UI    | CUVE              | . 401  | <u> •</u>                 |          |       |           |                 |  |  |
|                               | SMISSIONS FRI                                  | ∩M A.       | TS ^                             | D CHIMI | 7 0 7    | ATION   | US CE             | V T NI | CHE                       | ΛTL      | IED   | DA        | T A             |  |  |
| 33. MEASUREME                 |  | <u>um A</u> | <u> </u>                         | PUDIN   | <u> </u> | ATIU    | <u> </u>          | A T IA | U NE                      | <u> </u> | ICK   | UA        | 1 4             |  |  |
|                               |  |             |                                  |         |          |         |                   |        |                           |          |       |           |                 |  |  |
| 34. PRECISION 4               | ND ACCURACY                                    | -           |                                  |         |          |         |                   |        | <del> </del>              |          |       |           |                 |  |  |

TRANSPONDER NOISE FIGURE 4.5 DB, BANDWIDTH 100 KHZ

| 35. SPECTRAL R  | ANGE  | ·               |  |   |             | 36  | SPECTRA      | AL RE | SOLI | JTION       | 37. TIME    | CONST    | ANT  |  |
|---|---|-----------------|--|---|-------------|-----|--------------|-------|------|-------------|-------------|----------|--|--|
| 149.22  |   | 135.            | 0  | MHZ                                     |             | † · |              |       |      |             |             | <u> </u> | <u>.::::::::::::::::::::::::::::::::::::</u> |  |
| 38. FIELD OF VI   |   | <u> </u>        |  | 39. GROL                                |             | TH  |              |       |      |             |             |          |  |  |
| 17.3  |   |                 | EGI  | IMB-                                    | TO-L'1      | ME  | 19700        | ) NM  | ) f  | ROM         | GEO-S       | YNCH     | ALT  |  |
| 40. ANGULAR RESO  | LUTION 4  |                 |  |   |             |     |              | V .   |      |             | 1           |          | :  |  |
|   |   |                 |  |   |             |     |              |       |      |             |             |          |  |  |
| 42. POINTING ACCU   | 42. POINTING ACCURACY 43. POINTING RATE 44. ALTITUDE 45. INCLINATION              |                 |  |   |             |     |              |       |      |             |             |          |  |  |
|   | SYNCH CIRCULAR EQUATORIAL POSIGRADE   |                 |  |   |             |     |              |       |      |             |             |          |  |  |
| 46. SPECIAL REQUIREMENTS                                  |   |                 |  |   |             |     |              |       |      |             |             |          |  |  |
| 47 COMPONENTS   |   |                 |  |   |             |     |              |       |      |             |             |          |  |  |
| 47. COMPONENTS  VHE TRANSPONDER, ANTENNA SYSTEM, DIPLEXER |   |                 |  |   |             |     |              |       |      |             |             |          |  |  |
|   | 48. WEIGHT 49. VOLUME 50. AVERAGE POWER 51. STANDBY POWER 52. PEAK POWER 53. MTBF |                 |  |   |             |     |              |       |      |             |             |          |  |  |
| 29 LB 90 WATTS  |   |                 |  |   |             |     |              |       |      |             |             |          |  |  |
| 54. INTERFERENCE:   | 55. MAGI  | NETIC<br>FRENCE | 56 NUC   | CLEAR<br>FERENCE                        | 57. INT     |     | IAL<br>RENCE | 58. S | HIEL | DING        |             |          |  |  |
| SOURC/SEN   |   |                 | The second secon | 111111111111111111111111111111111111111 |             |     |              |       | ·    |             |             | 147      |  |  |
| 59. CALIBRATIC  |   |                 |  | 60. D/                                  | ATA REC     | cov | ERY          | A     | 1.   | 61. FRE     | QUENCY OF   | OBSERVA  | TION   |  |
|   |   |                 |  |   |             |     |              | -     |      | APPR        | 0X 2        | HOUR!    | S/DAY  |  |
| 62. TELEMETRY   | REQUIR  | EMENTS          |  | a vi                                    | N P v       |     |              |       |      | \$          |             |          |  |  |
| 2 KHZ INF   | ORMAT   | ION BA          | NDW  | IDTH                                    |             |     |              |       |      |             |             |          |  |  |
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